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ABSTRACT

This guide contains 43 modules of laboratory activities for technology education courses. Each module includes an instructor's resource sheet and the student laboratory activity. Instructor's resource sheets include some or all of the following elements: module number, course title, activity topic, estimated time, essential elements, objectives, activity overview, challenge statement, systems model, interfacing information for other disciplines, critical thinking skills reinforced, teaching tips, instructional strategy, equipment and supplies needed, evaluation key, support materials, recommended modifications for use with students with disabilities or limited English proficiency, and illustrations. Student activities contain some or all of the following elements: activity module number, course title, activity topic, activity overview, challenge statement, objectives, vocabulary and concepts reinforced, equipment and supplies, introduction to the activity, procedure, and evaluation. Some of the topics covered by the modules are the following: what is technology?, problem solving, team problem solving, inventions and innovations, digital video, computer animation, technical drawing, print shop, solar energy, wind energy, rubber-band powered vehicle, basic systems of manufacturing, building a lake house, transportation-related construction, batch manufacturing, computer simulation, the bridge design challenge, and acid rain. (KC)

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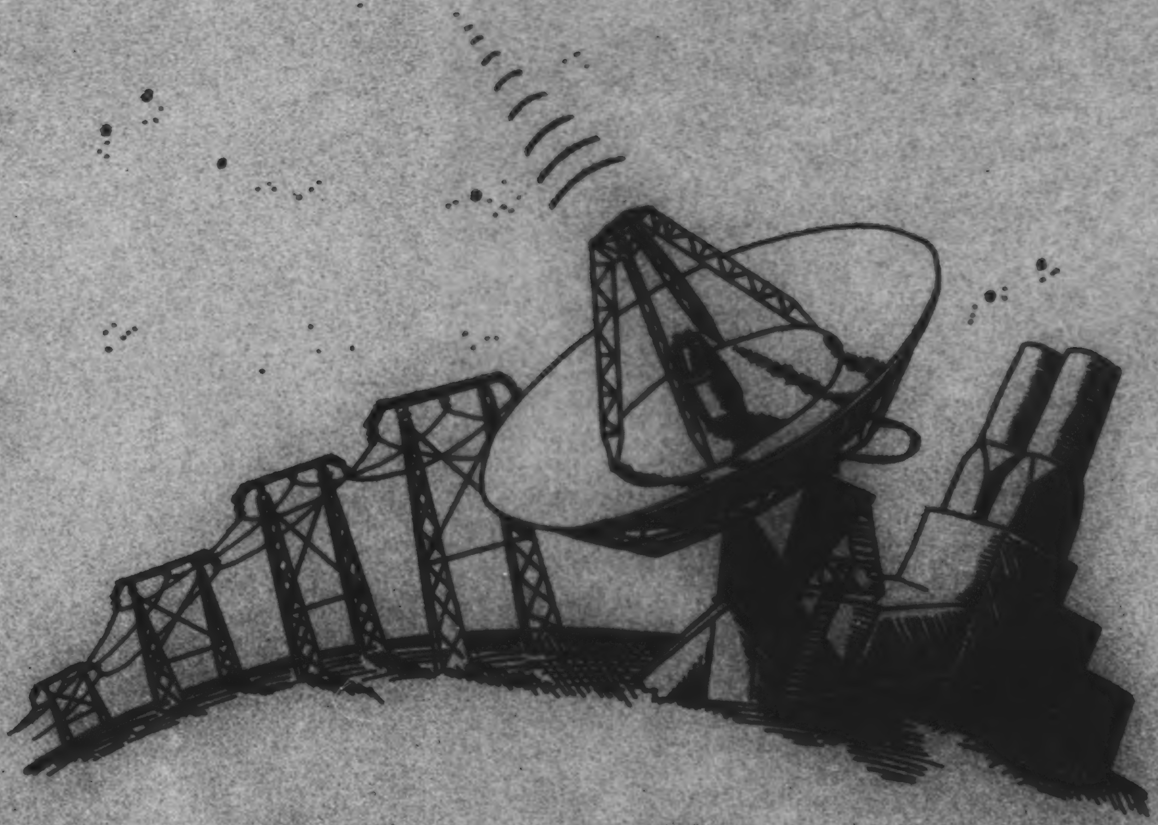
TECHNOLOGY SYSTEMS



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TECHNOLOGY SYSTEMS

LABORATORY ACTIVITIES

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Contents

Acknowledgments v
Organization of the Laboratory Activity Materials 1
Using the Laboratory Activity Materials 2
Instructional Planning Outline 3
Instructional Planning Worksheet 7
Technology Systems Essential Elements 9
TAAS Objectives 10

Module 1: What Is Technology? 11
Module 2: Introduction to Problem Solving 23
Module 3: Introduction to Problem Solving—Open-Ended Problems 37
Module 4: Introduction to Team Problem Solving—Basic Team Dynamics 43
Module 5: Team Problem Solving—Open-Ended Problems 51
Module 6: Introduction to Invention and Innovation 61
Module 7: Digital Video 67
Module 8: Computer Animation 73
Module 9: Solutions to Problems Created by Modern Technology 77
Module 10: Sharing Technology 83
Module 11: TELEvision COMMUNICATION 89
Module 12: Modern Telecommunication 101
Module 13: Basic Technical Drawing—Sketching 105
Module 14: Communicating without Words 111
Module 15: The Mighty Communication Challenge 115
Module 16: "Can You Sell a Cause?" 121
Module 17: Desktop Publishing 129
Module 18: Synchronous Communication Satellite (SYNCOM) 139
Module 19: Print Shop 147
Module 20: How Well Do You Communicate? 153
Module 21: Introduction to Futuring—Communication Systems 157
Module 22: Go/Stop/Go 163
Module 23: Solar Energy 169
Module 24: Wind Energy 177
Module 25: Biomass Energy 181
Module 26: Radio-Controlled Sunshine Racers 185
Module 27: Rubber-Band-Powered Vehicle 195
Module 28: Conventional and Alternate Energy Forms 201
Module 29: Introduction to Patents, Trademarks, and Copyrights 217
Module 30: The Invention Process—Basic Design and Modeling 225
Module 31: Basic Systems of Manufacturing 233
Module 32: Separating and Forming Polymers 241
Module 33: Building a Lake House 249
Module 34: Transportation-Related Construction 255
Module 35: Mass Production 265
Module 36: Batch Manufacturing 273
Module 37: Introduction to Futuring—Manufacturing Systems 283
Module 38: Introduction to Futuring—Construction Systems 287

Module 39: Computer System Simulation—SimCity....293
Module 40: The Boat Hull Design Challenge....299
Module 41: Testing Dome Designs....305

Comprehensive Integrated Modules

Module 42: The Bridge Design Challenge....315
  Technology Systems....317
  Physical Science....333
  Mathematics....341
Module 43: Acid Rain: "Pay Now or Pay Later"....349
  Technology Systems....351
  Physical Science....359
  Mathematics....369

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Alan L. Towler
Director, Educational Resources

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964: EXECUTIVE ORDERS 11246 and 11375; TITLE IX 1973 EDUCATION AMENDMENTS: REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulation by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs of activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.

Organization of the Laboratory Activity Materials

The major portion of this guide is the compilation of laboratory activity modules. The laboratory activity modules were developed, tested, and reviewed by technology teachers, supervisors, and teacher educators.

Each module includes (1) an instructor's resource sheet and (2) the student laboratory activity.

Each instructor's resource sheet includes the following elements, where applicable:

- Instructor's resource sheet module number
- Course title
- Activity topic
- Estimated time
- Essential elements (specific to Technology Systems)
- TAAS objectives
- Activity overview
- Challenge statement
- Systems model
- Interfacing with other disciplines
- Critical thinking skills reinforced
- Teaching tips
- Instructional strategy
- Equipment/supplies
- Evaluation key
- Support materials
- Recommended modifications for using the module activity for handicapped, disadvantaged, and/or LEP (Limited English Proficient) students where appropriate
- Illustrations

Each student activity includes the following elements, where applicable:

- Student activity module number
- Course title
- Activity topic
- Activity overview
- Challenge statement
- Objectives
- Vocabulary/concepts reinforced
- Equipment/supplies
- Introduction (to the activity)
- Procedure (step by step)
- Evaluation

Using the Laboratory Activity Materials

Intended Audience: The material in this guide is designed for use by technology teachers and students in grades nine through twelve. Many of the modules, however, would also be appropriate and recommended for use by junior high/middle school technology programs.

Length of Time for the Materials: The topic of study has been developed to provide materials for 18 to 36 weeks of study. Each module includes a suggested time frame for completion of the activity/module.

Benefits for Teachers and Students: The materials included in this guide were developed to assist technology teachers in planning, organizing, teaching, implementing, and evaluating a technology-based instructional program. The broad exposure students will receive by being involved in the laboratory activities in this guide will enhance their total educational program experience, including their problem-solving skills, creative thinking skills, and social interaction skills, as well as communication, computation, and technical skills.

Flexibility of the Materials: This guide, like other curriculum materials, does not attempt to encompass all situations. Therefore, teachers should supplement the guide with other appropriate ideas, information, and activities as needed in their particular programs.

A key feature in this guide is flexibility. The material may be used in the context of a large class/group approach, a small group approach where appropriate, and, in many of the modules, an individualized approach. In some of the modules, a combination of all three approaches might be incorporated.

Modules should be selected by the teacher in the order that he or she chooses, and the teacher is encouraged to expand or condense the student laboratory activity to meet the needs of addressing essential elements and the time frame designated to cover the topic. Teachers may also need to make substitutions in the use of each module, depending on the equipment, resources, and/or reference materials available.

Essential Elements/TAAS Objectives: Essential elements and TAAS objectives for reading, writing, and mathematics have been identified in each module (where appropriate). As used in this guide, essential element statements represent skills, knowledge, and/or attitudes that imply the ability or intelligence to accomplish an idea, problem, task, job, etc. Essential element statements will assist the teacher in clearly formulating the scope and sequence of the course of study and the purpose and processes for student learning.

Instructional Planning: An instructional planning outline and worksheet are included in the guide for teachers to use in their planning and preparation. The outline and worksheet should prove beneficial to teachers in enhancing their use of various instructional practices, in identifying appropriate teaching behaviors and process decisions, and in documenting teaching techniques selected.

Instructional Planning Outline

Domain I. Instructional Strategies

Criterion 1. Provides opportunities for students to participate actively and successfully

Indicator:
- a. appropriately varies activities
- b. interacts with students in group formats as appropriate
- c. solicits student participation
- d. extends students' responses/contributions
- e. provides ample time for students to respond to teacher questions/ solicitations and to consider content as it is presented
- f. implements instruction at an appropriate level of difficulty

Criterion 2. Evaluates and provides feedback on student progress during instruction

Indicator:
- a. communicates learning expectations
- b. monitors students' performances as they engage in learning activities
- c. solicits responses or demonstrations from specific students for assessment purposes
- d. reinforces correct responses
- e. provides corrective feedback, or none needed
- f. reteaches, or none needed

Domain II. Classroom Management and Organization

Criterion 3. Organizes materials and students

Indicator:
- a. secures student attention, or students are attending
- b. uses administrative procedures and routines which facilitate instruction
- c. gives clear administrative directions for classroom procedures or routines, or none needed
- d. maintains seating arrangements/grouping appropriate for the activity and the environment
- e. has materials, aids, and facilities ready for use

Criterion 4. Maximizes amount of time available for instruction

Indicator:
- a. begins promptly/avoids wasting time at the end of the instructional period
- b. implements appropriate sequence of activities
- c. maintains appropriate pace
- d. maintains focus
- e. keeps students engaged

Criterion 5. Manages student behavior

Indicator:
- a. specifies expectations for class behavior, or none needed
- b. uses techniques to prevent off-task behavior, or none needed
- c. uses techniques to redirect off-task behavior, or none needed
- d. uses techniques to stop inappropriate behavior, or none needed
- e. uses techniques to stop disruptive behavior, or none needed
- f. applies rules consistently and fairly
- g. reinforces appropriate behavior when appropriate

Domain III. Presentation of Subject Matter

Criterion 6. Teaches for cognitive, affective, and/or psychomotor learning and transfer

Indicator:
- a. begins instruction/activity with an appropriate introduction
- b. presents information in an appropriate sequence
- c. relates lesson content to prior or future learning
- d. provides for definition of concepts and description of skills and/or attitudes and interests
- e. provides for elaboration of critical attributes of concepts, psychomotor skills, and/or attitudes and interests
- f. stresses generalization, principle, or rule as a relationship between or among concepts, skills, and/or attitudes/interests
- g. provides opportunities for transfer
- h. closes instruction appropriately

Criterion 7. Presents information accurately and clearly

Indicator:
- a. makes no significant errors
- b. uses vocabulary appropriate to students
- c. explains content and/or learning tasks clearly
- d. stresses important points and dimensions of content
- e. clarifies student misunderstanding, or none needed

Criterion 8. Uses acceptable communication skills

Indicator:
- a. uses correct grammar
- b. pronounces words correctly and clearly
- c. uses accurate language
- d. demonstrates skill in written communication

Domain IV. Learning Environment

Criterion 9. Uses strategies to motivate students for learning

Indicator:
- a. relates content to student interests/experiences
- b. emphasizes the value/importance of the activity or content
- c. reinforces learning efforts of students
- d. challenges students

Criterion 10. Maintains supportive environment

Indicator:
- a. avoids sarcasm and negative criticism
- b. establishes climate of courtesy and respect
- c. encourages slow and reluctant students
- d. provides praise for specific performance
- e. establishes and maintains positive rapport with students

Domain V. Growth and Responsibilities

Criterion 11. Plans for and engages in professional development
Indicator: a. shows progress in completing professional growth requirements as agreed upon with appraiser(s), or none needed
b. stays current in content taught
c. stays current in instructional methodology

Criterion 12. Interacts and communicates effectively with parents
Indicator: a. initiates communications with parents about student performance and/or behavior when appropriate
b. conducts parent-teacher conferences in accordance with local district policy
c. reports student progress to parents in accordance with local district policy
d. maintains confidentiality unless disclosure is required by law

Criterion 13. Complies with policies, operating procedures, and requirements
Indicator: a. follows statutory and Texas Education Agency regulations
b. follows district and campus policies and procedures
c. performs assigned professional duties
d. follows district promotion/retention policy and procedures

Criterion 14. Promotes and evaluates student growth
Indicator: a. participates in campus goal-setting for student progress
b. plans instruction in accordance with district requirements
c. documents student progress
d. maintains accurate records
e. reports student progress at appropriate intervals

Instructional Planning Worksheet

Essential Element(s): ____________________

TAAS Objective(s): ____________________

Curriculum Guide Page: ____________________

Objective: At the conclusion of the lesson the learner will be able to:

____

____

____

____

Focus Activity: ____________________

____

____

a. Task for lesson: ____________________

____

b. Value of lesson to learner: ____________________

____

Explanation / Check Understanding:

a. ☐ Lecture ☐ Overhead ☐ Demonstration ☐ ____________________

b. ☐ Curriculum Guide page ______ ☐ Text page ______ ☐ ____________________

c. Modeling (teaching will) ____________________

____

____

d. Key questions to check understanding:

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________

Guided Practice Exercise:

☐ Exercise copied from overhead ☐ Handout worksheet no. ____________

☐ Copy from board ☐ Read sample problems ☐ ____________

____

____

Checking Mastery (Learning Progress)

☐ View each student's work ☐ Students check and signal correct

☐ ____________

____

Independent Practice: (reteach those needing help while others work)

☐ Worksheet No.________ ☐ Copy from overhead ☐ Copy from board

☐ Copy as dictated ☐ Reteach worksheet/outline number ____________

☐ ____________

☐ ____________

Extension: (Enrichment/Application)

☐ Worksheet No. ________ ☐ ____________

Describe how this activity makes relevant application of the lesson. ____________

____

____

Closure: Restate the learning. ____________

____

Method to involve the learner in the summary: ____________

____

Sponge Activities: Sponge focus activity no.: ____________

Other sponge activity no.: ____________

Technology Systems Essential Elements

Technology Systems is a laboratory-oriented course that includes the common essential elements for industrial technology education, plus the following concepts and skills related to communication, energy, and production technology. The student shall be provided opportunities to:

1. use sketching techniques to develop drawing format and graphic problem solving;
2. describe objects accurately through the principles of shape and size descriptions;
3. develop products using photographic materials and equipment;
4. design and produce graphic arts materials;
5. explore the major electronic communication systems, including telecommunication;
6. apply computer software to design and make drawings;
7. explore the conversion, control, storage, and transmission of various forms of energy;
8. demonstrate the use of conventional and alternate sources of energy;
9. apply and explain the principles of internal/external combustion engines;
10. demonstrate the principles of mechanical, electrical, and fluid power;
11. explore the basic principles of electrical systems;
12. investigate the methods of transporting people, material, and information;
13. apply production processes of casting, forming, separating, conditioning, assembling, and finishing to selected materials;
14. use the manufacturing management components, such as planning, organizing, directing, and controlling personnel, to design, engineer, produce, and market a product;
15. investigate the construction subsystems of design, management, and building;
16. apply automated systems in the production of products, including robots and computer numerical control;
17. organize a construction enterprise for selecting materials used in the various types of construction;
18. identify the criteria for selecting materials used in the various types of construction; and
19. explore applications of communication, energy, and production technology in a space environment.

TAAS Objectives

ENGLISH LANGUAGE ARTS

Reading Comprehension (RC)
Objective 1: Determine the meaning of words.
2: Identify supporting ideas.
3: Summarize written texts.
4: Perceive relationships and recognize outcomes.
5: Analyze information to make inferences/generalizations.
6: Recognize points of view, propaganda, and/or fact and nonfact.

Written Communication (WC)
Objective 1: Respond appropriately to the purpose/audience in a written composition.
2: Organize ideas in a written composition.
3: Demonstrate control of the English language in a written composition.
4: Generate a written composition which develops and supports a central idea.
5: Recognize appropriate sentence construction.
6: Recognize appropriate word usage.
7: Recognize within the context of a written passage:
a. correct spelling of words.
b. correct capitalization.
c. appropriate punctuation.

MATHEMATICS

Concepts (C)
Objective 1: Demonstrate an understanding of the concepts of numbers.
2: Demonstrate an understanding of mathematical relations, functions, and other algebraic concepts.
3: Demonstrate an understanding of geometric properties and relationships.
4: Demonstrate an understanding of measurement concepts using metric and customary units.
5: Demonstrate concepts related to an understanding of probability and statistics.

Operations (O)
Objective 1: Demonstrate skills, concepts, and applications related to addition.
2: Demonstrate skills, concepts, and applications related to subtraction.
3: Demonstrate skills, concepts, and applications related to multiplication.
4. Demonstrate skills, concepts, and applications related to division.

Problem Solving (PS)
Objective 1: Estimate solutions.
2: Analyze problems and identify solution strategies.
3: Express problems using mathematical representations.
4: Evaluate the reasonableness of problem solutions.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 1
(1–2 WEEKS)

WHAT IS TECHNOLOGY?

Essential Elements: 1, 2, 10, 13–15, 18
TAAS Objectives: Language Arts: RC 1–6; WC 6, 7
Mathematics: C 1–5; O 1–4; PS 1–4

Activity Overview

This activity will provide introductory material that is a basis for all other learning modules and is essential to student understanding of later lessons. The following will be defined or identified: *technology, resources of technology, problem solving, technological systems, trigger events.* Student groups will build a structure containing at least 15 triggers.

Challenge Statement

Society changes rapidly in response to technological innovations. An understanding of and appreciation for technology will help students adjust to changes and participate in innovative developments.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Material handling
Cutting
Shaping
Bonding
Testing

Applications
Problem solving
Teamwork
Technology appreciation

Impact
Group interaction
Problem solving

Interfacing with Other Disciplines

Language Arts:	Students will read and write to complete the activity.
Mathematics:	Students will add, subtract, divide, multiply, and measure to complete the activity.
Science:	Students will participate in a discussion of the elements of physics in the mechanical movement of trigger mechanisms.
Social Studies:	Students will be aware of cause-and-effect relationships and their social impacts.

Critical Thinking Skills Reinforced

Students will apply systems model processes to real-life experiences and trigger device designs. After they develop and construct their designs, they will demonstrate their triggers and determine whether any redesigns are necessary. Students will record observations and appraisals on given worksheets for evaluation.

Teaching Tips

1. Use discussion and student interaction to teach the material on technology, resources of technology, the systems approach, problem solving (scientific method), trigger effect, and consequences. Use two days for introductory materials and discussion.
2. Have the students complete the handouts as the discussion progresses. A suggestion would be to require students to have a notebook for your class and to keep all assignments in their notebook. All handouts would then be available to students on a daily basis and serve as a record of their activity in your class.
3. Allow three days for completion of the structure. Use one day for group presentations and triggering structures.
4. It would be most helpful to have examples of successful trigger mechanisms to demonstrate. Explain the concept behind your design to allow your students to apply the process to their designs.

Instructional Strategy

Secure student attention by focusing on trigger designs. Transfer the process to the systems model for application to everyday, real-life situations. Monitor students for participation and encourage reluctant students through praise for any endeavor. Check for understanding by requesting demonstrations of trigger designs throughout the construction phase of the activity. Close the activity with completion of the worksheets and demonstrations of trigger devices.

Equipment/Supplies

1. Hand tools
2. Scissors
3. X-acto knives
4. Abrasives
5. Fasteners
6. Scrap wood
7. Metal
8. Styrofoam
9. Cardboard
10. Paper or plastic
11. String
12. Glue
13. Rubber bands
14. Paper clips
15. Tools

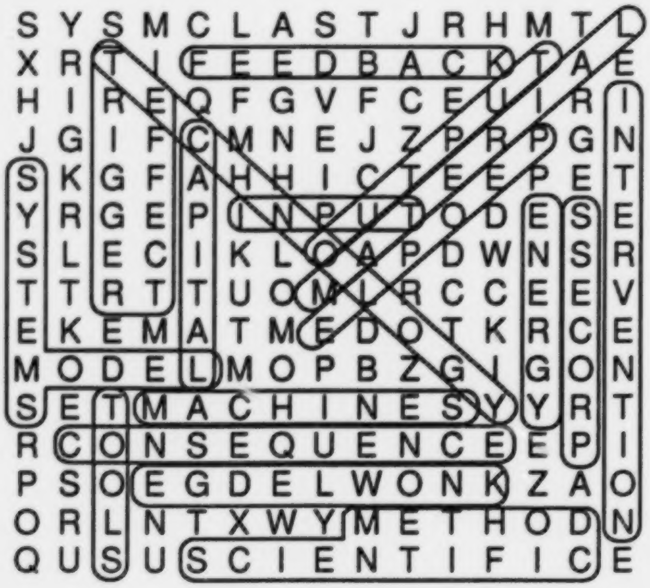
Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special-needs students. Teaming special students with non-special-needs students is one method of ensuring that they participate in the activity. Check with the special education department for ways to handle specific problems.

Encourage improvement of the student's self-image. Identify the student and call him or her by name as soon as possible.

Evaluation Key

The students should be assigned an individual daily grade for work completed, ability to work within a small group, and safe behavior in the laboratory situation. Each group will design its own version of "The Aftermath." The worksheet provides space for a description of each trigger and will be turned in at the completion of the assignment. The performance of "The Aftermath" will be checked against the worksheet and the triggers identified by the students. At least 15 successful triggers will be necessary, and the worksheet list will act as a guideline to compare with the 15 events as they take place. The instructor should set guidelines as to how high a grade will go for additional triggers beyond the minimum 15. A grade should be given to the group as a whole for its performance of "The Aftermath."



S Y S M C L A S T J R H M T L
X R T I F E E D B A C K T A E
H I R E Q F G V F C E U I R I
J G I F C M N E J Z P R P G N
S K G F A H H I C T E E P E T
Y R G E P I N P U T O D E S E
S L E C I K L O A P D W N S R
T T R T T U O M L R C C E E V
E K E M A T M E D O T K R C E
M O D E L M O P B Z G I G O N
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R C O N S E Q U E N C E E P I
P S O E G D E L W O N K Z A O
O R L N T X W Y M E T H O D N
Q U S U S C I E N T I F I C E

WHAT IS TECHNOLOGY?

NAMES OF GROUP MEMBERS: DATE: ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

LIST OF TRIGGERS

	SUCCESSFUL?	
	YES	NO
1. ______________________________	☐	☐
2. ______________________________	☐	☐
3. ______________________________	☐	☐
4. ______________________________	☐	☐
5. ______________________________	☐	☐
6. ______________________________	☐	☐
7. ______________________________	☐	☐
8. ______________________________	☐	☐
9. ______________________________	☐	☐
10. ______________________________	☐	☐
11. ______________________________	☐	☐
12. ______________________________	☐	☐
13. ______________________________	☐	☐
14. ______________________________	☐	☐
15. ______________________________	☐	☐

16. ____________________ ☐ ☐

17. ____________________ ☐ ☐

18. ____________________ ☐ ☐

19. ____________________ ☐ ☐

20. ____________________ ☐ ☐

21. ____________________ ☐ ☐

22. ____________________ ☐ ☐

23. ____________________ ☐ ☐

24. ____________________ ☐ ☐

25. ____________________ ☐ ☐

22

TECHNOLOGY EDUCATION

Definition of Technology:

____

____

____

____

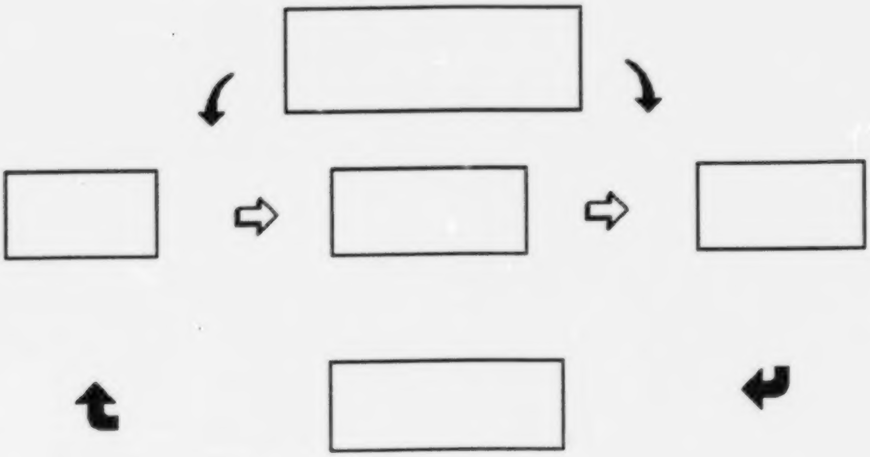
Resources of Technology:

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________
6. ____________________________
7. ____________________________

Steps Used in Problem Solving:

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________

SYSTEMS OF TECHNOLOGY MODEL



Trigger Effect:

Trigger ____________________ Consequence ____________________

Trigger ____________________ Consequence ____________________

Trigger ____________________ Consequence ____________________

Trigger ____________________ Consequence ____________________

Trigger ____________________ Consequence ____________________

WHAT IS TECHNOLOGY?

Activity Overview

This activity will provide introductory material that is a basis for all other learning modules and is essential to your understanding of later lessons. The following will be defined or identified: *technology, resources of technology, problem solving, technological systems, trigger events.* Student groups will build a structure containing at least 15 triggers.

Challenge Statement

Society changes rapidly in response to technological innovations. An understanding of and appreciation for technology will help you adjust to changes and participate in innovative developments.

Objectives

- To identify the resources of technology
- To list the steps used when solving a problem
- To work in groups with other students
- To list the components of a technological system
- To work safely in a laboratory setting
- To define *technology*

Vocabulary/Concepts Reinforced

- Technology
- Scientific method
- Systems model
- Input
- Process
- Output
- Capital
- Energy
- Knowledge
- Machines
- Materials
- People
- Trigger effect
- Consequence
- Feedback
- Intervention
- Tools

Equipment/Supplies

- Hand tools
- Scissors
- X-acto knives
- Abrasives
- Fasteners
- Scrap wood
- Metal
- Styrofoam
- Cardboard
- Paper or plastic
- String
- Glue
- Rubber bands
- Paper clips
- Tools

Introduction

This unit is a basis for all other units. Technology, for these learning experiences, will be defined as "the use of our knowledge, tools, and skills to solve practical problems and to extend human capabilities" (Todd, McCrory, Todd, *Understanding and Using Technology,* 1985). The resources of technology that will be studied throughout these modules are as follows: capital, energy, knowledge, machines, materials, people, and tools. When these resources are combined, technological problems can be solved.

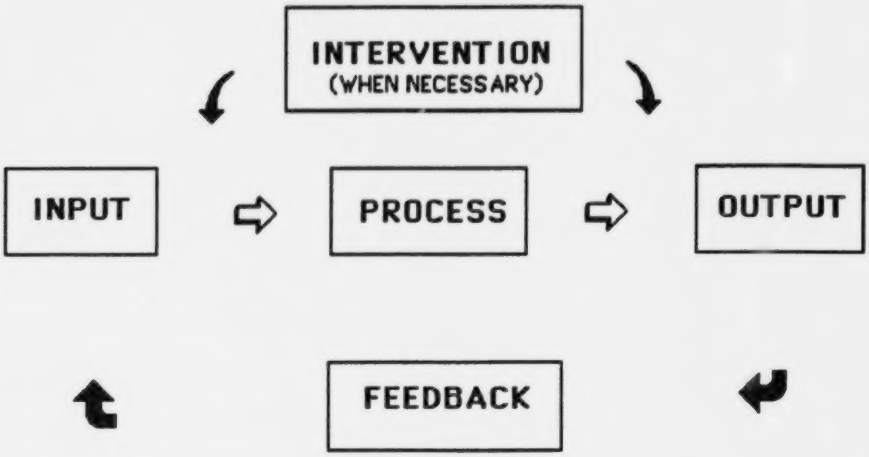
Your instructor will divide you into groups to build "The Aftermath," a structure that should contain at least 15 different successful triggers from beginning to end. This activity is based on the old Mattel game called "Mousetrap," the object of which is to put all of the pieces of the trap together, such that when a trigger is released, a series of events takes place that eventually captures a playing piece in a mousetrap. The activity is complex and does not end in a playing piece being captured. The events in the structure should be limited only by imagination and safety concerns. To stimulate the problem-solving aspect of this assignment, the instructor may place certain limitations on the structure that you may build, such as (but not limited to):

1. use a marble in one or more sections;
2. do not use a burning candle as a trigger;
3. stay within a size limit of 2' x 2' x 2'; and
4. any other limits or qualifiers that the instructor may choose to impose.

Bring items from home that could be used in building the structure.

Procedure

1. List the resources of technology; provide examples of each resource.
2. Explain the steps used in solving problems:
   a. Observe a given situation.
   b. Define the problem as observed.
   c. Create alternative solutions and choose the best ones to test as hypotheses.
   d. Collect data and analyze results.
   e. Select the most appropriate course of action.
3. Study the systems model.



SYSTEMS MODEL

This model will be used to evaluate all technological systems investigated during this course of study. Resources of technology are the inputs to the system. All of the resources go through one process or another to arrive at the output phase. The output is measured against the desired outcome, and feedback is generated. Any alterations to the output are called interventions and take place before or after the process phase of the system.

4. Make a list of examples of such a system: e.g., a thermostat, going to school, getting ready for a date, etc. Explain how feedback provides information so that intervention can take place to improve the system when necessary: e.g., the house is too warm and the air conditioner should turn on, testing students to see if they are learning the correct material, looking in the mirror to make sure that one's appearance is perfect.
5. Study the trigger effect (cause and effect) and the significance of one event triggering another: e.g., if you pass all classes, you can participate in extracurricular events; the invention of movable type allowed more books to be printed and more people to become literate; the invention of steam engines helped bring about the industrial revolution.
6. Ask your instructor for objectives, expected student outcomes, and grading procedures.
7. Design the structure, fill out the trigger sheet, build the structure, test it, and develop a short informal presentation on your version of "The Aftermath."
8. Demonstrate your group's product to the class.

Evaluation
Submit completed designs and worksheets to your instructor.

WORD SEARCH

Find the following words:

Technology
Scientific method
Systems model
Input
Process
Output
Capital
Energy
Knowledge
Machines
Materials
People
Trigger effect
Consequence
Feedback
Intervention
Tools

The words may be horizontal, vertical, diagonal, or backwards.

S Y S M C L A S T J R H M T L
X R T I F E E D B A C K T A E
H I R E Q F G V F C E U I R I
J G I F C M N E J Z P R P G N
S K G F A H H I C T E E P E T
Y R G E P I N P U T O D E S E
S L E C I K L O A P D W N S R
T T R T T U O M L R C C E E V
E K E M A T M E D O T K R C E
M O D E L M O P B Z G I G O N
S E T M A C H I N E S Y Y R T
R C O N S E Q U E N C E E P I
P S O E G D E L W O N K Z A O
O R L N T X W Y M E T H O D N
Q U S U S C I E N T I F I C E

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 2
(2 DAYS)

INTRODUCTION TO PROBLEM SOLVING

Essential Elements:	1 and others, depending on student solutions
TAAS Objectives:	Language Arts: RC 1–6 Mathematics: C 3–5; PS 1–4

Activity Overview

This activity is the first in a series of activities designed to introduce students to basic problem solving. The activity will serve as a building block for future related activities.

Challenge Statement

Students will be provided with two activities to introduce the basic elements of problem solving as it relates to industrial technology.

Systems Model

Resources
Background information

Processes
Design
Material handling
Cutting
Shaping

Applications
Open-ended problem solving
Closed-ended problem solving

Impact
Real-world problem solving

Interfacing with Other Disciplines

Language Arts:	Students will understand the importance of sequencing events in problem-solving situations.
Mathematics:	Students will use measurement and problem solving to complete the activity.
Science:	Students will be made aware of another problem-solving method similar to the scientific method.
Social Studies:	Students will be aware of cause-and-effect relationships and their social impacts.

Critical Thinking Skills Reinforced

Students will analyze a problem and apply sequential problem-solving steps to solve the problem. They will be encouraged to transfer these steps to different real-life situations. They will consider and assess various options before determining the final solution.

Teaching Tips

1. Lecture to present the topic to students.
2. Adjust the time frame to meet the needs of your students.
3. Encourage creative thinking by your students.
4. Use informal discussion as needed with individual students and groups to explore the topic and check for understanding.

Instructional Strategy

Demonstrate examples of problem solving to gain the attention and interest of your students. Use graphic illustrations to help facilitate learning and hold focus. Use informal discussions to evaluate student progress and check for understanding.

Equipment/Supplies

Handout 2-1: Puzzle pieces

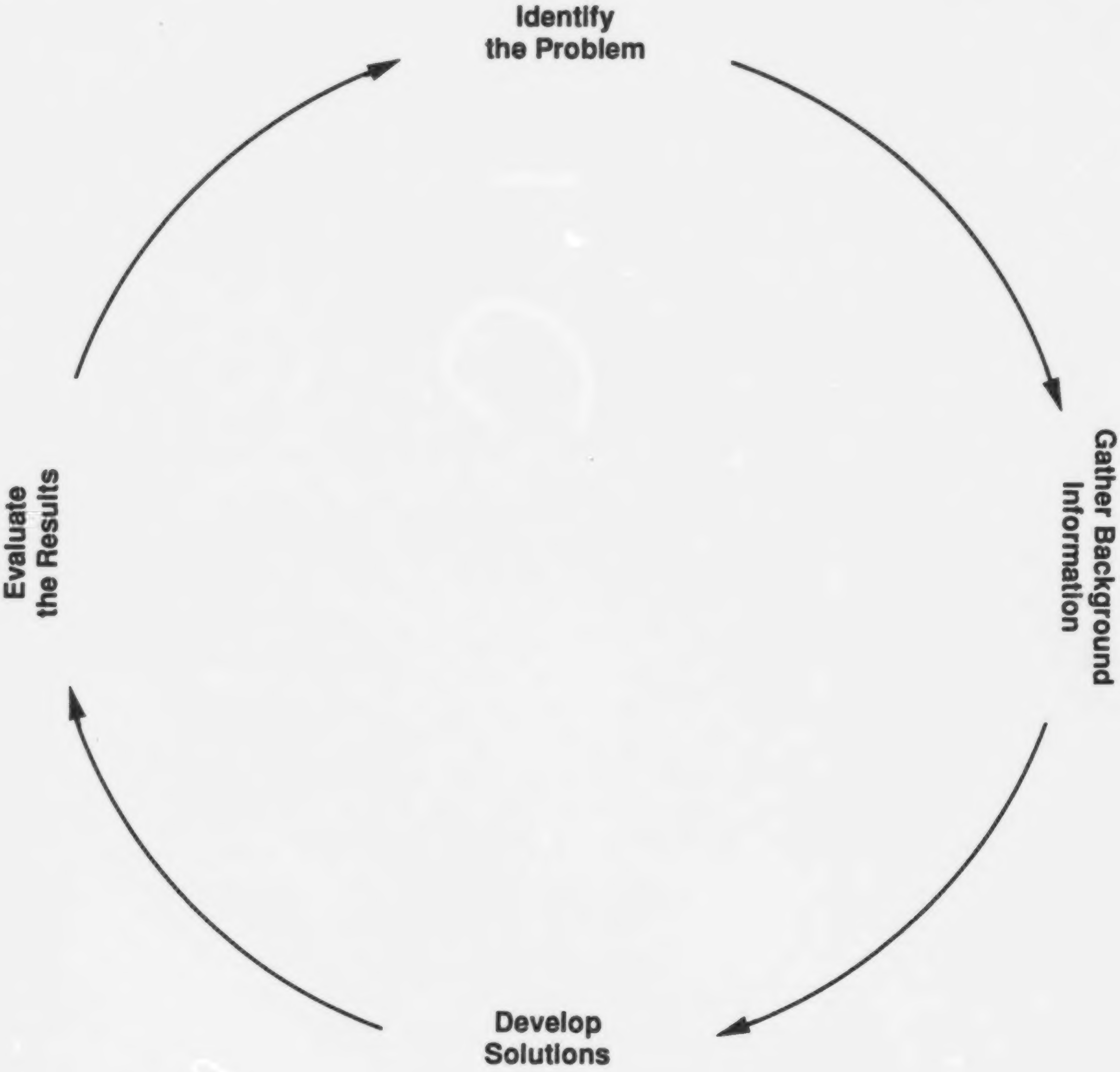
Evaluation Key

Evaluation of student performance will be based on participation in and completion of the activity.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students. Check each student's permanent records for ways to handle specific problems. Help LEP students develop a good self-concept through positive feedback.

The Problem Solving Loop



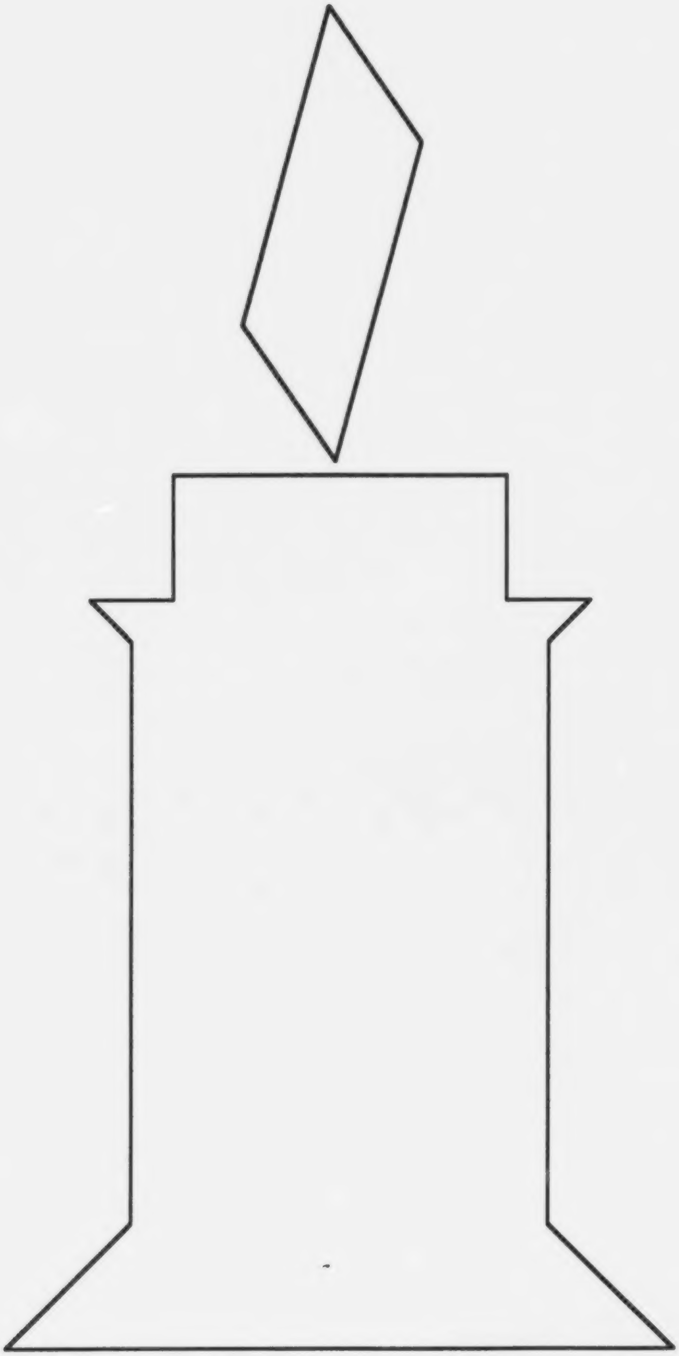
Identify the Problem

Gather Background Information

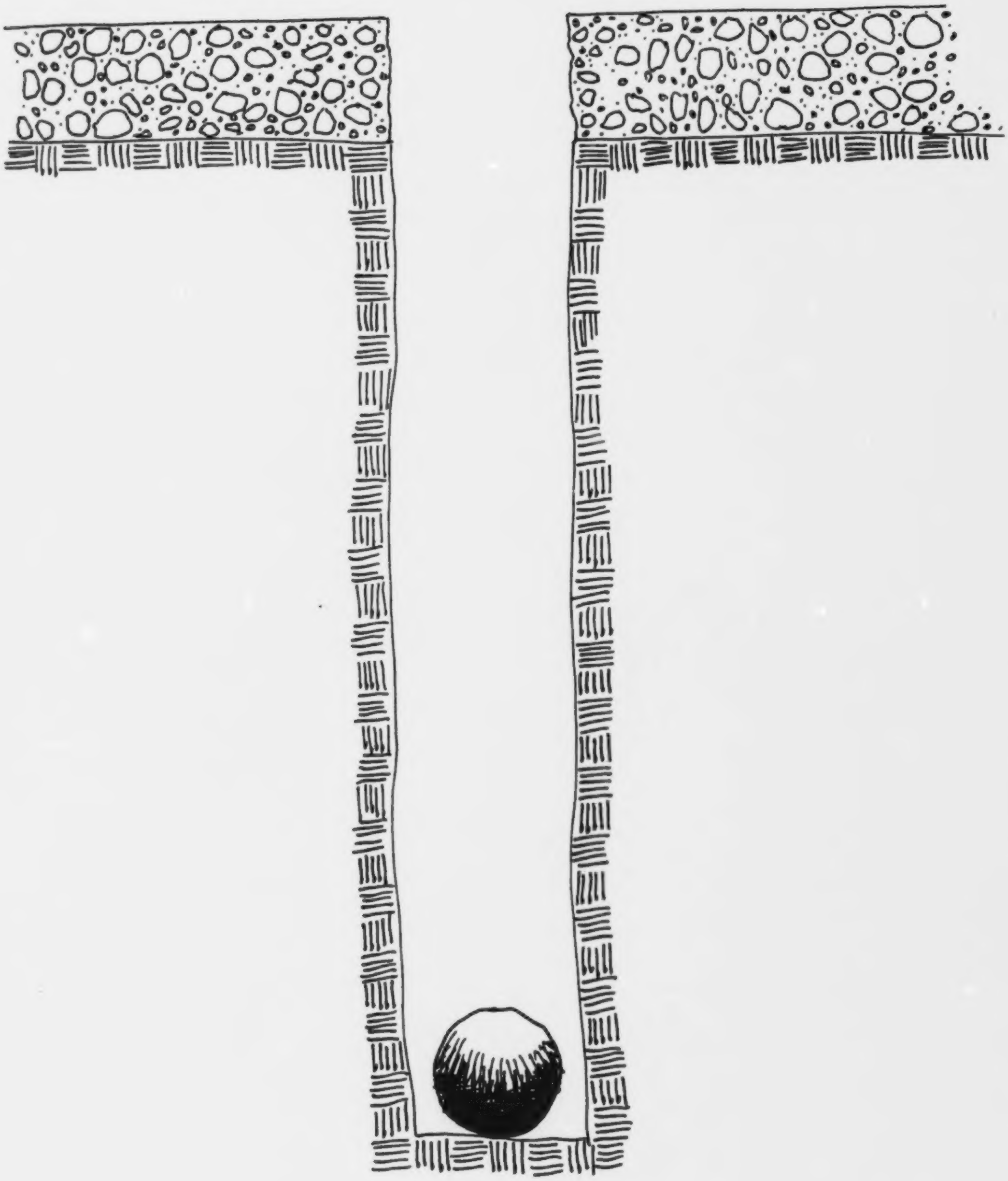
Develop Solutions

Evaluate the Results

TRANSPARENCY 2-1

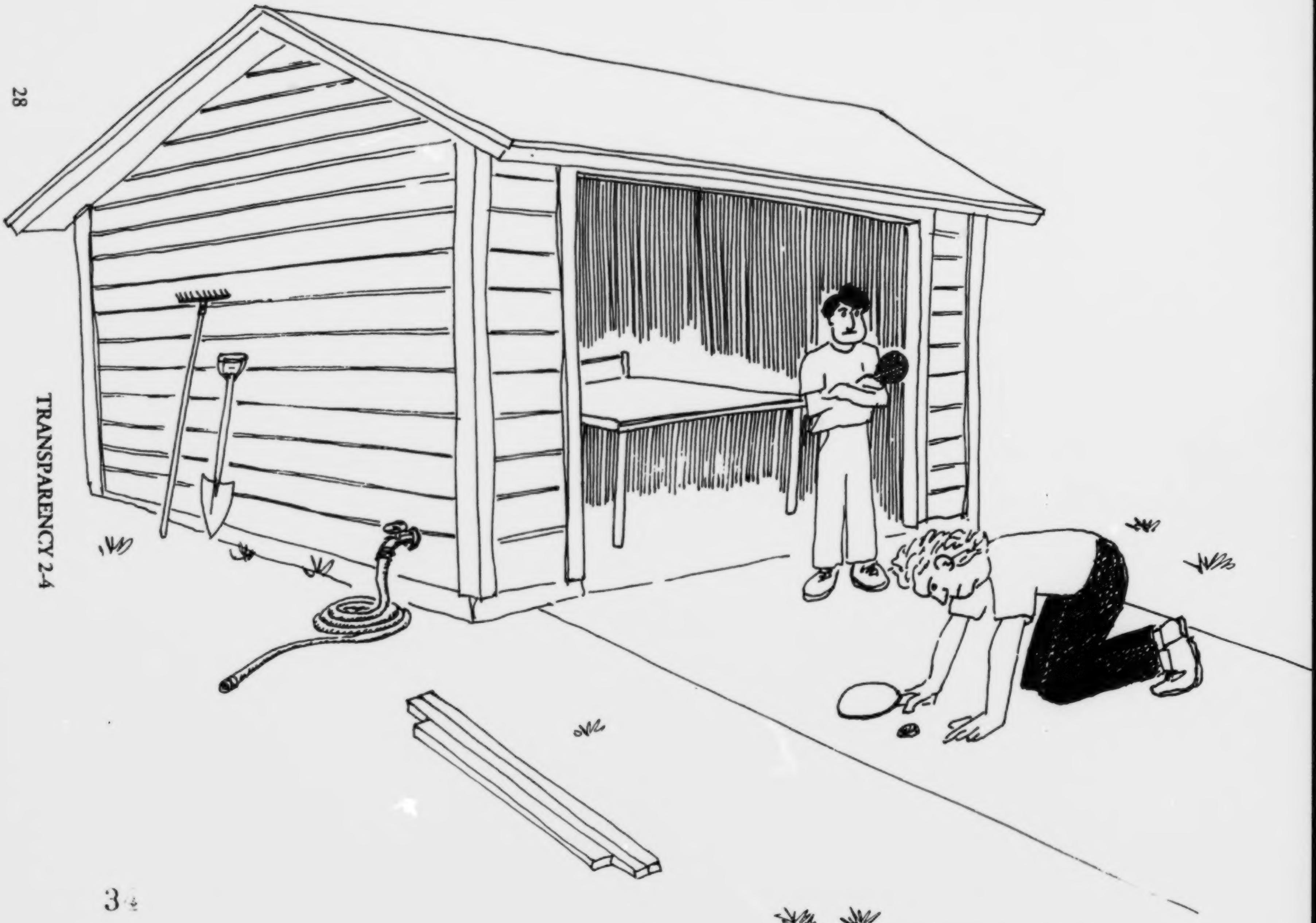


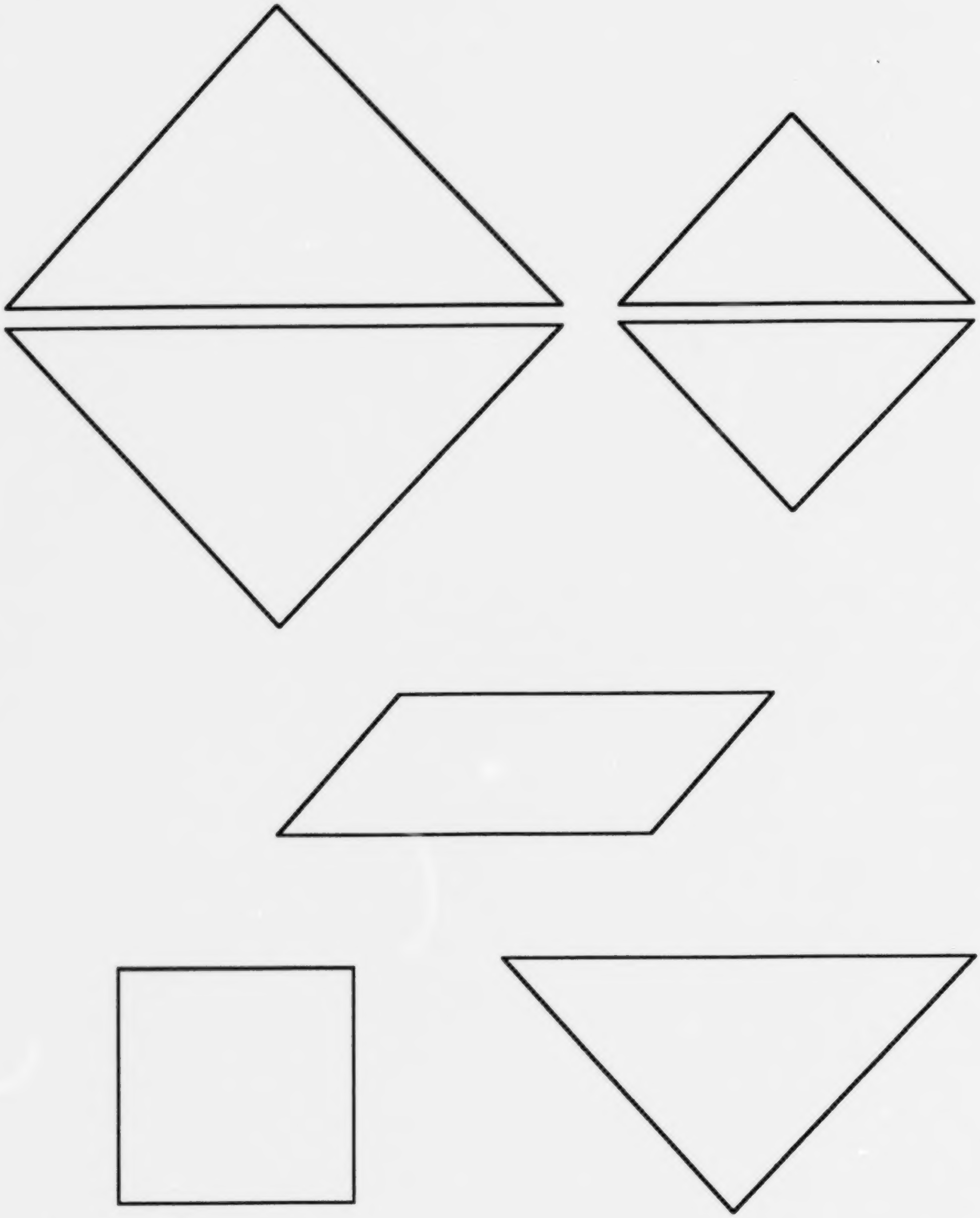
TRANSPARENCY 2-2



TRANSPARENCY 2-3

TRANSPARENCY 2-4





HANDOUT 2-1

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 2

INTRODUCTION TO PROBLEM SOLVING

Activity Overview
This activity is the first in a series of activities designed to introduce you to basic problem solving. The activity will serve as a building block for future related activities.

Challenge Statement
You will be provided with an open-ended problem and a closed-ended problem to introduce the basic elements of problem solving as it relates to technology.

Objectives
- To define problem solving as it relates to industrial technology
- To be able to describe and discuss basic close-ended problems
- To be able to describe and discuss basic open-ended problems

Vocabulary/Concepts Reinforced
- Closed-ended problem
- Open-ended problem

Equipment/Supplies
- Handout material
- Puzzle pieces

Introduction
Industry relies heavily on workers who not only are educated and trained to perform managerial and technical skills, but also possess critical thinking skills. As our country approaches the twenty-first century, the ability to recognize and go about solving problems is going to be one of the most important attributes of individuals entering the work force. Many industrial technology educators feel that critical thinking skills can be learned and should be included as an integral part of the industrial technology curriculum.

Technology Systems is a course designed specifically to introduce high school students to the many aspects of industry and technology. Throughout this course you will have an opportunity to experience many of the technological systems used by industry, including communication, energy, transportation, manufacturing, production, and construction. As you will see, problem solving is a common thread which runs through each of the activities, just as it does through each of the technologies in industry.

What is problem solving? Basically, problem solving is the ability to recognize, define, and go about the process of solving technical problems. Many writers in this area feel that problem solving is a process having a definite sequence of steps that one must go through in order to find solutions. It may be a simple process involving a problem that some might solve in only a few minutes—for example, figuring out how to sharpen a pencil without a pencil sharpener. This problem may not seem difficult for most of us, but for some it may very well be a major task. On the other hand, problem solving may involve hundreds of people who, no matter how hard they try, still cannot find a solution to the problem. They might not even be able to agree on what the problem actually is. An example of this type of problem is the attempt to change the perception of the American public that American-built cars are just as good as Japanese-built cars.

Problem solving does not have to be a complicated process. Basically, there are two types of problems that you will encounter in the technical world. Some problems offer one basic solution. These are referred to as "closed-ended" problems. A simple example of a "close-ended" problem might be the following:

> While driving along a deserted country road, a driver suddenly realizes that he has a flat tire. He pulls over to the side of the road, gets out of his car, and observes the tire. He definitely has a problem, the flat tire, but he knows how to change a flat tire so he opens the trunk of his car, pulls out the spare tire and tire-changing equipment, then goes about changing the tire.

However, some problems don't have easy solutions. These problems occur when you are "blocked" and really don't know what to do about a problem. These problems are referred to as *open-ended,* because there is generally not one specific solution to the problem. Consider the same situation above with a slightly different set of circumstances:

> The driver of the car realizes that he has a flat tire. He pulls over to the side of the road, gets out to observe the flat tire, and thinks that he simply has to change the flat and be on his way home. However, when he opens his trunk, he realizes that, although he has a spare tire, he doesn't have a jack to lift his car. Now, he has a real *problem,* and there does not seem to be an easy solution. The driver may become blocked with no idea of how to go about changing the flat tire.

It is important to understand that when we discuss problem solving, we are talking about a *process.* This process involves a combination of creative thinking and critical thinking to be effective. Finding the solution to the problem is important, but we are primarily concerned with the actual sequences through which one must work to find a solution. It is this set of events that a problem solver must learn to use in order to become a technical problem solver. Literature on the subject of problem solving describes a variety of process steps, but they can all be broken down to a few common elements:

1. Identifying and evaluating the problem
2. Gathering background information
3. Developing solutions
4. Evaluating the results

Identifying and evaluating the problem is the first step in the sequence. Remember that closed-ended problems have only one answer or one obvious choice. Open-ended problems, however, are where problem solvers need to develop their critical thinking skills. Open-ended problems present many possible solutions and require higher-level thinking skills to solve.

Open-ended problems are presented in many different forms. In industry, they are often very complex and may require the effort of several people to define. Industry identifies open-ended problems through various operations such as marketing, research and development, production, and management. Although each is a separate operation, they often work together to solve complex open-ended problems.

The second step in the problem-solving process is to **gather** as much **background information** as possible. This information may hold the key to a possible solution to the problem at hand. Background information includes any information that may have a bearing on solving the problem. Even if it seems minor or inconsequential, any information related to the problem is important. Background information may also be referred to as resource material or research information. However you wish to describe it, background information should be analyzed before trying to develop a solution to the problem.

The third stage in the process is to **develop a solution** to the problem. A solution to a technical problem is accomplished when the initial problem no longer exists. Solutions are developed in many different ways. Some result from the effort of a single individual, while others require teams of people working together to be successful.

When you begin developing a solution to a problem, it is important to think creatively. Problem solvers need to develop creative thinking skills which will break them away form the "habit thinking" that we normally do when faced with a problem situation. Habit thinking relates to how we normally do things, how we put on our socks, tie our shoes, cross our legs, etc. It is often part of the blocking process that prevents us from solving problems. If we can break away from habit thinking, we will find that problem solving becomes a fun and often exciting way to approach life.

One of the most productive methods for solving problems is to "brainstorm." Brainstorming is a process by which a problem solver lists as many possible solutions to a problem as he or she can possibly think of, even if they seem farfetched and unworkable. Brainstorming requires some degree of creative thinking and imagination to work and may be one of the most important elements of the problem-solving process.

The fourth and final stage of the problem-solving process is to **evaluate the results** to determine whether the problem was actually solved. In the case of the man with the flat tire, was he able to actually change the tire and be on his way down the road? If he found a solution to his problem, he was successful. If, on the other hand, he did not, and remained blocked, he was unsuccessful. Oftentimes, the more complex the original problem appears, the more difficult it is to determine whether or not the solution is one that will actually solve the problem. If it does not, the problem solver should start over again and analyze each step of the process. The problem-solving process becomes a loop through which the problem solver might need to make several passes to find a workable solution (transparency 2-1). In many real-world situations, problem solving is an ongoing process, and a single solution is not expected, although improvements are made to existing technology and progress is made toward an ultimate end.

Procedure

For the purposes of this first activity you will work individually to solve two types of problems. The first problem is a closed-ended problem in which there is only one solution. The second problem is an open-ended problem in which there are several possible solutions.

Problem Number 1

This problem is designed to help you understand the concept of a closed-ended problem. It will also help you to begin to think creatively as you start to solve more complex problems. This problem is based on an ancient Chinese puzzle which has been used for more than a thousand years to study mathematical phenomena and develop critical thinking skills. The problem is based on the specific arrangement of seven puzzle pieces. The design that you are to create is just one of approximately 16,000 different designs. Your goal is to arrange the seven puzzle pieces into the shape shown in transparency 2-2 within five minutes. Remember that there is only one correct solution to this problem.

Your instructor will provide a set of puzzle pieces. You will need to cut out each piece as neatly as possible. Your task is to place the puzzle pieces into the correct order to form the shape within the allotted time. As you begin to solve the puzzle, think about the problem-solving loop and how it might help in finding a solution to the problem.

After the allotted time has elapsed, find out how many students were able to solve the puzzle. How many students felt "blocked" by the problem? How many felt pressed by the time limit? How many students gave up without trying through the entire time limit? These are just some of the feelings that are associated with problem solving. Did the problem-solving loop help?

Problem Number 2

This problem is an example of an open-ended problem. You will attempt to solve this problem on your own and again within a given time frame. The problem is based on the following set of circumstances.

While playing ping-pong with his friend Tommy, Jimmy misses the ball and it rolls outside the garage and falls into a hole that has recently been bored through the concrete driveway. The hole in the ground is about three feet deep and only slightly wider than the ball is round. Since it is the only ping-pong ball that they have, they are eager to get it back and resume their game. The two boys can't figure out how to retrieve their ball; they are "blocked" and need your help.

Your task in this part of the activity is to utilize the problem-solving loop to help the boys figure out how to get the ball out of the hole. Study transparencies 2-3 and 2-4, which show the ball in the hole and the surroundings in which the boys are playing. As you begin to utilize the problem-solving loop, remember that you are not limited to the resources shown in the drawings; there may be other items typically found in a garage that you might be able to use. Your instructor will give your class 20 minutes to complete the activity.

When the designated time period has elapsed, you will be asked to discuss your solution with the class. Remember, in an open-ended problem, there is not just one correct answer. There may be hundreds of possible solutions. Successful problem solvers are able to develop the most practical solutions. As you discuss your solutions with the class, your instructor will list them on the chalkboard. View each solution in terms of its potential to really solve the problem in a practical manner.

Evaluation
Teacher evaluation of student performance will be based on your participation in and completion of the activity.

(2 DAYS)

INTRODUCTION TO PROBLEM SOLVING—OPEN-ENDED PROBLEMS

Essential Elements:	1, 2, (4)
TAAS Objectives:	Language Arts: RC 1–6
	Mathematics: C 1–4; O 1–4; PS 1–4

Activity Overview
This activity is the second in a series of problem-solving projects. In this activity students will work to further their understanding of open-ended problems. This activity will also serve to expand their creative and critical thinking skills.

Challenge Statement
Packaging is critical in industry in terms of product protection, cost effectiveness, and environmental concerns. Your students will design packaging to learn to work through an open-ended problem-solving situation.

Systems Model
Resources
Background information

Processes
Design loop
Material handling
Cutting, shaping, assembling

Applications
Open-ended problem solving

Impact
Problem solving in industry

Interfacing with Other Disciplines

Language Arts:	Students will read information about packaging to solve a packaging problem. They will understand the importance of proper sequencing in problem solving situations.
Mathematics:	Students will use measurement and problem solving to complete the package design activity.
Science:	Students will be made aware of another problem-solving method similar to the scientific method.
Social Studies:	Students will be aware of packaging and its relationship to waste and landfills.

Critical Thinking Skills Reinforced

Application skills are used to transfer given background information into the problem-solving loop. Analysis is used by students to understand the problem components, while synthesis is used by students to create and design various solutions to the problem. Students will evaluate their own work to determine whether their solutions solve the stated problem.

Teaching Tips

1. Lecture to present the topic to students.
2. Adjust the time frame to meet the needs of your students.
3. Encourage creative thinking by your students.
4. Arrange for a guest speaker to talk to your class about local landfill conditions.
5. Obtain a video program related to waste and landfill management that can be used to help introduce the problem presented in this activity.
6. If possible, visit your local landfill and videotape the conditions that exist there.

Instructional Strategy

Demonstrate examples of problem solving to get the attention of your students as you open the activity. Use graphic illustrations to facilitate learning and maintain interest. Monitor students to ensure proper sequencing of the problem-solving process. Allow and encourage students to evaluate each other's work throughout the activity.

Equipment/Supplies

1. One five-stick package of chewing gum per student
2. Drawing paper
3. Rulers
4. Construction paper
5. Glue
6. Scissors

Evaluation Key

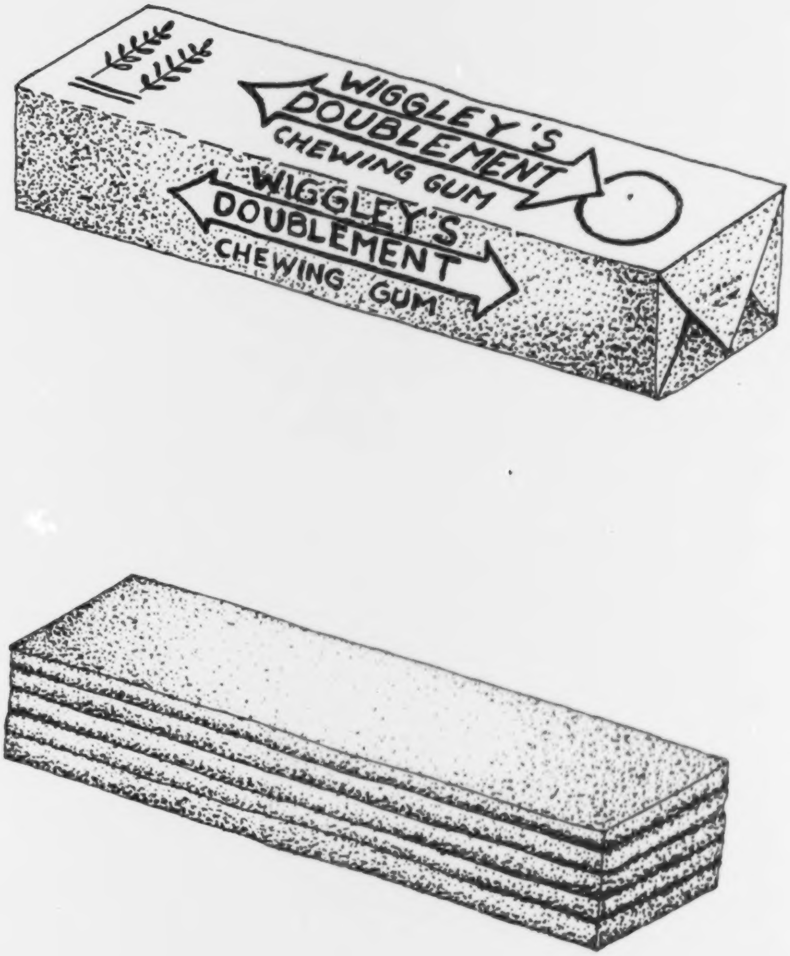
Teacher evaluation of student performance should be based on participation in and completion of the activity. Each student will be graded on his or her presentation and end product.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students. When possible, arrange to have students with similar disabilities assigned to the same class. Use visual examples for instructions to supplement written and oral instructions.

Illustrations

Transparency 3-1



TRANSPARENCY 3-1

INTRODUCTION TO PROBLEM SOLVING—OPEN-ENDED PROBLEMS

Activity Overview

This activity is the second in a series related to problem solving. In this activity students will work individually to further explore open-ended problems.

Challenge Statement

Every little piece of paper adds to the landfill, no matter how insignificant it seems. Packaging products for health and safety is important, but manufacturers must also be concerned about the volumes of waste from their products.

Objectives

- To further discuss problem solving as it relates to industry and technology
- To discuss and describe the basic steps in the problem-solving process
- To discuss and describe open-ended problems

Vocabulary/Concepts Reinforced

- Packaging
- Landfill
- Waste management
- Recycling

Equipment/Supplies

- One five-stick package of chewing gum per student
- Drawing paper
- Glue
- Scissors
- Ruler
- Construction paper

Introduction

One of the most important technological problems facing the world today is the negative impact that product packaging has on the environment. Product packaging creates an enormous amount of waste material, much of which finds its way into our nation's landfill systems. Although some progress has been made in the practice of recycling, discarded packaging continues to pile up and contributes to our nation's waste management crisis.

The purpose of this activity is take a firsthand look at this critical environmental condition and provide you with an exercise in which you can work directly with a realistic open-ended problem. Your instructor will lead you through the procedural steps below.

Procedure

1. Your instructor will present background information related to local landfill conditions and the system of waste management in your community.
2. After this discussion each student will be given a package of chewing gum containing five sticks of gum. Do not open the package until asked to do so.
3. Study the package. You probably know, based on experience, what is inside the package. Basically, there are five sticks of chewing gum, each wrapped with a layer of foil and paper. The chewing gum is the product, and the wrapper is the packaging material.
4. Now, unwrap each piece of gum, stack the five sticks together, and place them beside the wrapper material. Observe the product in relation to the amount of packaging material (transparency 3–1). You can easily see that there is more waste material than necessary for the amount of product being sold. This is a real-world problem. Many of the products marketed today are packaged this same way. The product is easily consumed while the packaging material ends up in the local landfill.
5. Your task for this activity is to design and produce a prototype packaging system that eliminates as much waste as possible. Remember that this is an open-ended problem and there are many possible solutions. The only design criterion that you must address is the health issue requiring that the product must be wrapped when sold. The amount of product will remain the same. This does not mean, however, that it must be in the form of five sticks. It is also important to note that the product must be packaged so that it can be easily marketed to the consumer.
6. Use the materials provided by your instructor to help solve the packaging problem. Think through each step of the problem-solving loop and work to develop several ideas. Select one idea that you feel best addresses the problem and make a prototype of that idea.
7. At the end of the designated time, your instructor will ask each student to present his or her solution to the problem. Solutions will be evaluated on how well they meet the solution criteria.

Evaluation

Teacher evaluation of student performance will be based on your participation in and completion of the activity. Each student will be graded on his or her presentation and end product.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 4
(1 DAY)

INTRODUCTION TO TEAM PROBLEM SOLVING—BASIC TEAM DYNAMICS

Essential Elements: 1, 2, 12
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1

Activity Overview

This activity is the third in a series of problem-solving projects. In this activity, students work in small groups to further their understanding of teamwork and its relation to problem solving. This activity will also serve to expand their creative and critical thinking skills through the dynamics of teamwork.

Challenge Statement

Teamwork in industry is similar to teamwork in athletics. Your class will work in teams to solve a life-threatening problem.

Systems Model

Resources
Background information

Processes
Problem-solving loop
Material handling

Applications
Teamwork
Problem solving

Impact
Teamwork in industry
Industrial problem solving

Interfacing with Other Disciplines

Language Arts:	Students will read a situation, determine the problem and resources, solve the problem, and present their solution. They will understand the importance of proper sequencing in problem solving.
Mathematics:	Students will use measurement and the problem-solving loop to solve a life-threatening problem.
Science:	Students will use scientific principles related to buoyancy to solve a problem.
Social Studies:	Students will work in a team to solve a problem.

Critical Thinking Skills Reinforced

Students will apply given information and transforming resources to solve a technical problem. They will rearrange and reorder the resources provided to the team to find a solution. Synthesis will be used by the group to devise a method of moving the team from one island to the other. The entire class will assess the success or failure of each team.

Teaching Tips

1. Lecture to present the topic to students.
2. Adjust the time frame to meet the needs of your students.
3. Encourage your students' creative thinking.
4. Discuss the importance of teamwork and individual responsibility to the success of the team.
5. Use graphic illustrations to help facilitate learning.
6. Arrange for a guest speaker to talk to your class about teamwork and group responsibilities.
7. Obtain a video program related to teamwork and its relationship to problem solving in industry.
8. Depending on the class, it may be advantageous to assign teams so that no student will feel left out.

Instructional Strategy

Explain the situation to motivate student interest. Encourage cooperation in all teams. You may find it necessary to intervene in case of disagreements. Discuss compromise, design, and redesign with each group. Allow students to evaluate each other in the presentation.

Equipment/Supplies

1. Two island platforms 4' x 4' x 10"
2. One 2" x 6" x 5' board
3. One 2" x 6" x 3' board
4. One 2" x 6" x 2' board

Evaluation Key

Teacher evaluation will be based on participation in and completion of the activity. Each group will present its solution and receive a grade for the presentation.

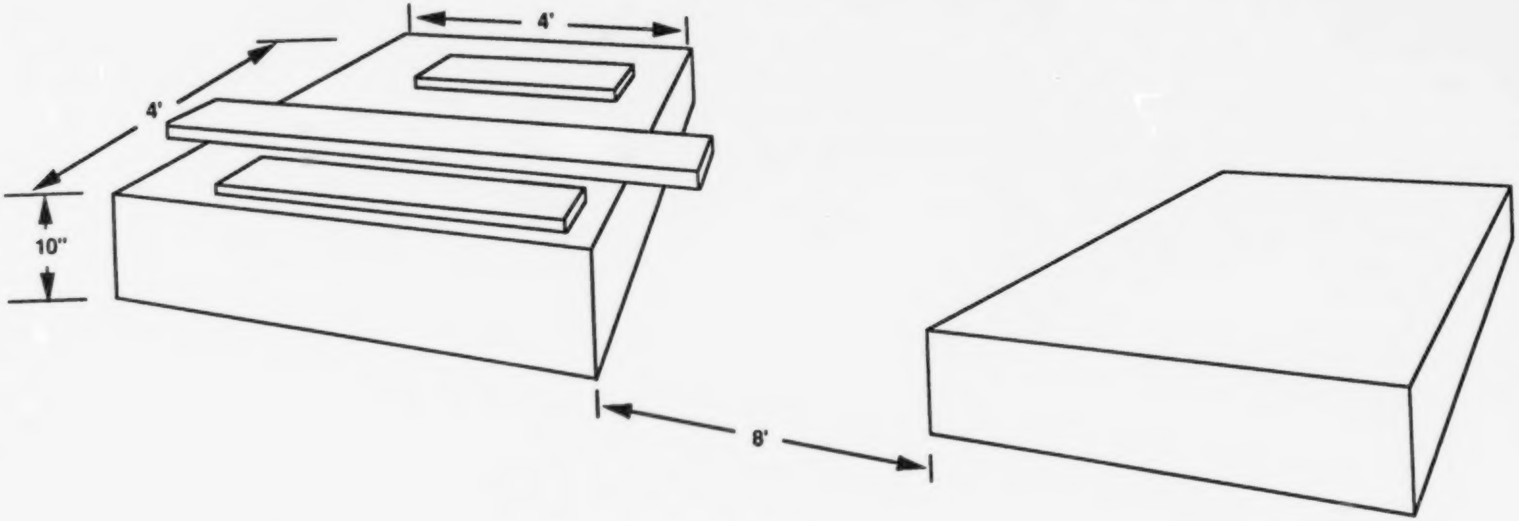
Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students. Students with physical handicaps, however, may have difficulty with this activity. Provide individualized attention where appropriate. Help special-needs students develop good self-concepts through positive feedback and encouragement.

Illustrations

Transparency 4-1

TRANSPARENCY 4-1



INTRODUCTION TO TEAM PROBLEM SOLVING—BASIC TEAM DYNAMICS

Activity Overview
This activity is the third in a series related to problem solving. In this activity, students will work in small groups to further explore the dynamics of teamwork in open-ended problem solving.

Challenge Statement
Teamwork in industry is similar to teamwork in athletics. You will work in teams to solve a life-threatening problem.

Objectives
- To discuss problem solving as it relates to teamwork in industry and technology
- To discuss and describe the basic steps in the problem-solving process
- To discuss and describe open-ended problems

Vocabulary/Concepts Reinforced
- Problem solving team
- Team dynamics
- Brainstorming

Equipment/Supplies
- Two island platforms 4' x 4' x 10"
- One 2" x 6" x 5' board
- One 2" x 6" x 3' board
- One 2" x 6" x 2' board

Introduction
Industry relies heavily on the dynamics of teamwork to solve many of its technical problems. Often, the problems encountered in an industrial setting are quite complex and require the efforts of several individuals working as a group to find a solution. The old adage that "two heads are better than one" forms the basis for teamwork in industrial problem solving.

Teamwork in industry is similar to the type of teamwork used by an athletic team. On an athletic team, the coach utilizes each player in a position where that player can benefit the performance of the entire team. The coach studies each player and learns his or her individual strengths and weaknesses and applies those talents where they can add to the overall performance of the team. Often, the team's success or failure is tied directly to how well individual members of the team perform their assigned tasks.

Industrial problem-solving teams are similar to athletic teams in that they take advantage of individual strengths and require each member to participate and to cooperate with other members of the team. One primary difference, though, is that industrial teams have little time for practice and in most cases rely on individual creative and critical thinking skills to be successful. The combination of individual initiative, cooperation, and participation makes up the dynamics of successful teams. How efficiently these dynamics work together often determines the success or failure of the problem-solving process.

Teamwork is not limited to large industrial corporations. It is a necessary function in almost all business and industrial settings where more than one person is at work. In large corporations, problem-solving teams may include multiple workers from all divisions of the company, including marketing, production, design, and management. In smaller operations, a problem-solving team may only include four to five workers assigned to a particular problem. The number of members is generally tied directly to the complexity of the problem and the amount of resources that management is willing to expend on the solution.

This activity is designed to help show you the importance of utilizing the individual strengths of team members. It will also help to illustrate how team dynamics affect the success of the team. Follow the set of directions below.

Procedure

1. [illegible]

   Situation: Your team is stranded on a desert island with no food, water, and no means for summoning a rescue. Next to your island is another island that contains all the food and water that your team can consume, as well as a radio that can be used to call for help. The water between the two islands is infested with hungry sharks that will eat anyone who so much as touches the water. The only items on the desert island are a few pieces of wood. These are your only resources other than the collective creativity of your team. (Transparency 4-1)

2. Your task is to move the entire team from the desert island to the other island. You cannot leave anyone behind; you must take the entire team. This is an all-or-nothing problem. Each member of the team must get from the desert island to the other island in order for your team to successfully solve the problem.

3. Your instructor will give your team a time limit of ten minutes to solve the problem. The instructor will observe your team but will not be able to provide any help. If any member of the team touches the water, the entire team will be expected to return to the desert island and start over again.

4. Upon completion of the activity by the entire class, your instructor will lead a discussion of teamwork and group dynamics. In your discussion of the activity, address some of the following issues:

- Cooperation
- Participation
- Personal attributes
- What caused your team to be successful?
- What caused your team to be unsuccessful?
- How would you approach the problem differently?
- How do you view the element of creativity as a component of problem solving and group work?

Evaluation

The entire class will evaluate each group based on the success of the cup using only the given materials.

TEAM PROBLEM SOLVING—OPEN-ENDED PROBLEMS

Essential Elements: 1, 4, 12
TAAS Objectives: Language Arts: RC-1, 6

Activity Overview
This activity is the fourth in a series of problem-solving projects. The focus of this activity is to help expand the creative and critical thinking skills of students within a teamwork situation.

Challenge Statement
The new republics of the former Soviet Union must meet the challenge of providing food for their people as their economies change. Your students will use open-ended problem solving to convert tanks into tractors.

Systems Model
Input
[illegible]

Process
Problem-solving loop
Structure building
Cutting
Assembly

Applications
Team problem-solving strategies
Open-ended problems

Impact
Team problem solving in industry

Interfacing with Other Disciplines

Language Arts:	Students will read a situation, determine the problem and resources, research information to aid in a solution, solve the problem, and present their solutions. They will understand the importance of proper sequencing in problem solving.
Mathematics:	Students will use measurement and the problem-solving loop to solve a problem.
Science:	Students will use scientific principles related to mechanical properties to solve a problem.
Social Studies:	Students will work in a team to solve a problem of major world impact.

Critical Thinking Skills Reinforced
[illegible] and transform a design engineered for one purpose into [illegible]

to the redesign of useful agricultural machinery. Synthesis is used to redesign the tank and construct the tractor. Students will evaluate each other to assess the resulting designs to determine whether the problem was solved.

Teaching Tips

1. Adjust the time frame to meet the needs of your students.
2. Encourage creative thinking by your students.
3. Discuss the importance of team dynamics and how individual contributions to the team are important to the success of the team in solving problems.
4. Discuss the use of brainstorming and sketchstorming in developing solutions to problems.
5. Arrange for two or three other teachers to serve as a simulated United Nations Special Committee.
6. Create a bulletin board display of various types of farm equipment. Obtain catalogs from farm equipment suppliers that students can use as reference material for design ideas.
7. Use a follow-up discussion to summarize the importance of teamwork to solve complex technical problems.

Instructional Strategy

Use current events to introduce the topic and get your students' attention. Organize necessary tools and equipment in advance for best use of time. Give students clear instructions on expected outcomes of the activity. Monitor students throughout the activity and provide additional resources, if necessary, to stimulate their creative energies. Group presentations will provide evaluation and closure.

Equipment/Supplies

1. Tank pattern
2. Drawing paper
3. Pencils
4. Colored markers
5. Glue
6. Construction paper
7. Scissors

Evaluation Key

Teacher evaluation will be based on participation in and completion of the activity. Each group will present its solution and receive a grade for the presentation.

Modifications for Handicapped, Disadvantaged, and LEP Students.

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students.

Illustrations

Handout 5-1: pattern sheets for tank

TEAM PROBLEM SOLVING—OPEN-ENDED PROBLEMS

Activity Overview
This activity is the fourth in a series related to problem solving. In this activity students will work in small groups to further explore the dynamics of teamwork in open-ended problems. Students will simulate the work of consulting engineers hired by the new Russian government to convert Soviet armored vehicles into farm tractors.

Challenge Statement
The new republics of the former Soviet Union must meet the challenge of providing food for their people as their economies change. With an excess of military equipment, it would be helpful to convert tanks into tractors for farm use.

Objectives
- To discuss problem solving as it relates to teamwork in industry and technology
- To discuss and describe the basic steps in the problem-solving process
- To discuss and describe open-ended problems
- To design and fabricate a basic prototype based on a set of given criteria

Vocabulary/Concepts Reinforced
- Brainstorming
- Sketchstorming

Equipment/Supplies
- Tank pattern
- Drawing paper
- Pencils
- Colored markers
- Glue
- Construction paper
- Scissors

Introduction
We have seen a very dramatic change in the world order with the dismantling of the Soviet Union. It appears that the "cold war" between Western countries and the Soviet bloc is over, and both sides can now channel their political and economic power into more positive directions.

The dismantling of the Soviet Union has created several smaller independent republics with borders very similar to those that existed before the Soviet Union was formed. One of the most important challenges facing the leaders of these new republics is to improve the production of farm products and their distribution to consumer markets. The failure of the communist system is partly due to its inability to provide enough food and other consumer goods for its own people. The issue of food production and distribution will certainly become one of the major issues facing these newly formed republics as they begin to reestablish themselves as independent nations.

This activity is designed to simulate the development of a possible solution to this production and distribution problem. You and your team will simulate the workings of a consulting team that has been directed by the United Nations to help solve part of this massive technical problem. Some of the things that the new republics desperately need are tractors and transportation vehicles. The United Nations has agreed, in this simulation, to provide plows and other farm implements for each tractor produced. The United Nations council responsible for this operation has suggested that the thousands of military tanks and other armored vehicles now sitting in storage areas throughout the republics be converted for use as farm tractors and transportation vehicles. Your team of problem solvers has been chosen to participate in helping to find a way to convert tanks into tractors.

Procedure

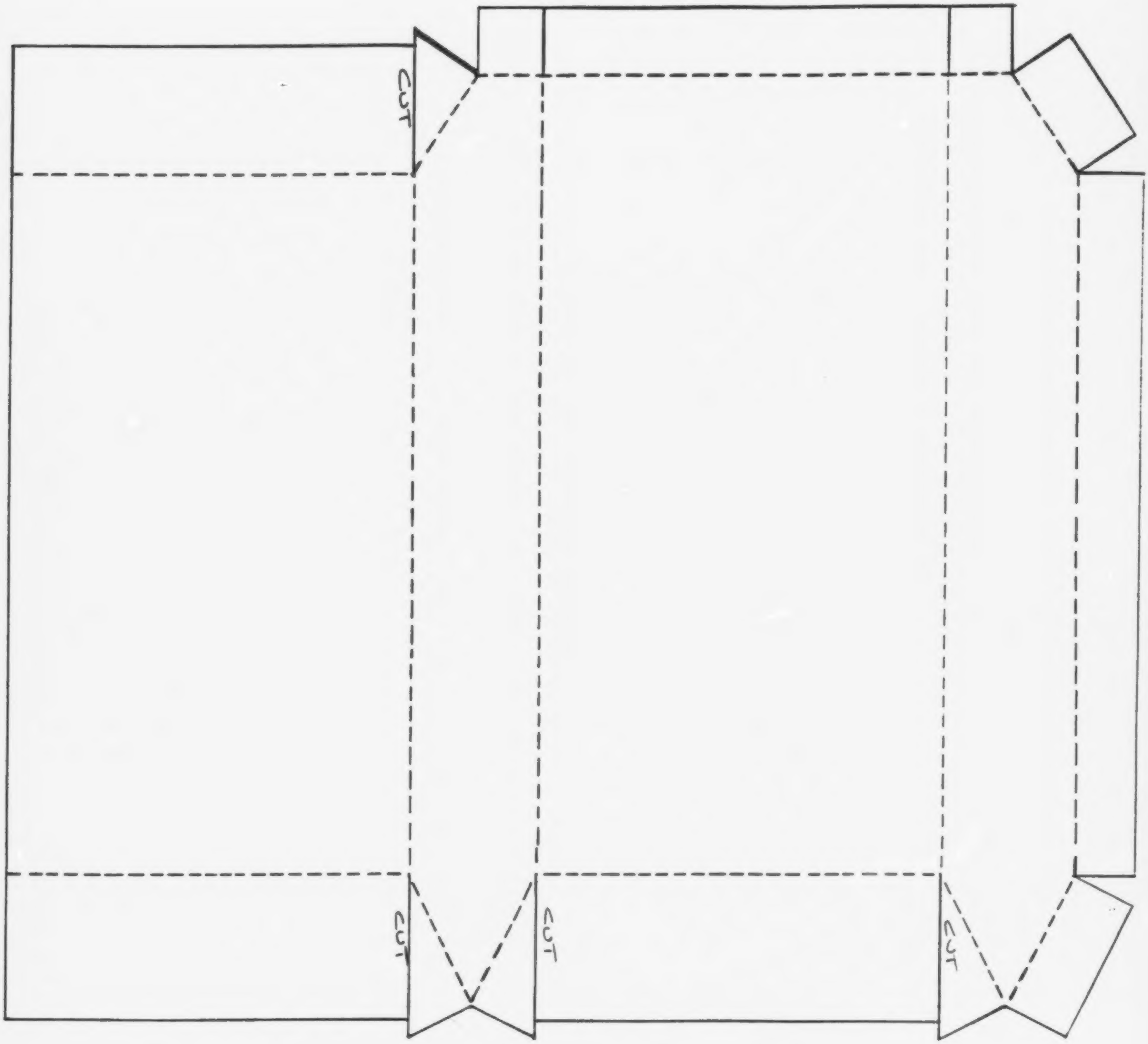
1. Begin the activity by forming your design team. Your instructor will assign members to each group or team. The instructor will also designate a completion date for all groups to be finished with their design and ready for a presentation of their work.
2. Each group will be permitted to form a work area within the technology lab. If your lab area has individual desks, arrange them into a star pattern. If your lab area has large work tables, make sure that they are cleared off to provide a clean work area.
3. Each group or team needs to fill the following positions:
    a. Group leader: The group leader is the manager for the group. He or she is responsible for keeping the group on task and on time.
    b. Recorder: The recorder is responsible for keeping a record of the group's ideas and progress throughout the activity.
    c. Reporter: The reporter is responsible for reporting the results of the group to the instructor as well as selling the group design prototype to the United Nations Special Committee.
    d. Logistics manager: The logistics manager is responsible for obtaining materials and equipment for the group. He or she will also be responsible for securing the group project at the end of class.
4. After your group has assigned itself these four positions, you should proceed with developing your design prototype. There are no detailed specifications other than "here is a tank, and we need it to be converted into a farm tractor." Utilize as much of the tank as possible, keeping in mind that it no longer needs to be used to fire its cannon or other guns.
5. Your group should brainstorm as many ideas as possible. Follow the four elements of brainstorming as your group begins its design work. Use the drawing paper provided by your instructor to "sketchstorm" ideas on paper. Don't rule out any designs at this time even if they seem farfetched or off the wall. Save all of these designs, because you may end up using bits and pieces from each.
6. When you feel that your group has exhausted all of its creative resources and has enough material to begin developing its prototype, obtain the necessary materials from your instructor and begin assembling the prototype.

7. At the designated time, your instructor will ask each group to present its design prototype to the class and try to sell its tank conversion to the United Nations Special Committee. This committee will listen to all of the presentations and select the one design from your class that best meets the needs of the people who will use the farm machinery.
8. Upon completion of the selection process, your instructor will lead a discussion of teamwork and how effective it was in the solution of the problem associated with this activity.

Evaluation

Teacher evaluation of student performance will be based on your participation in and completion of the activity. Each student will be graded on his/her presentation and end product.

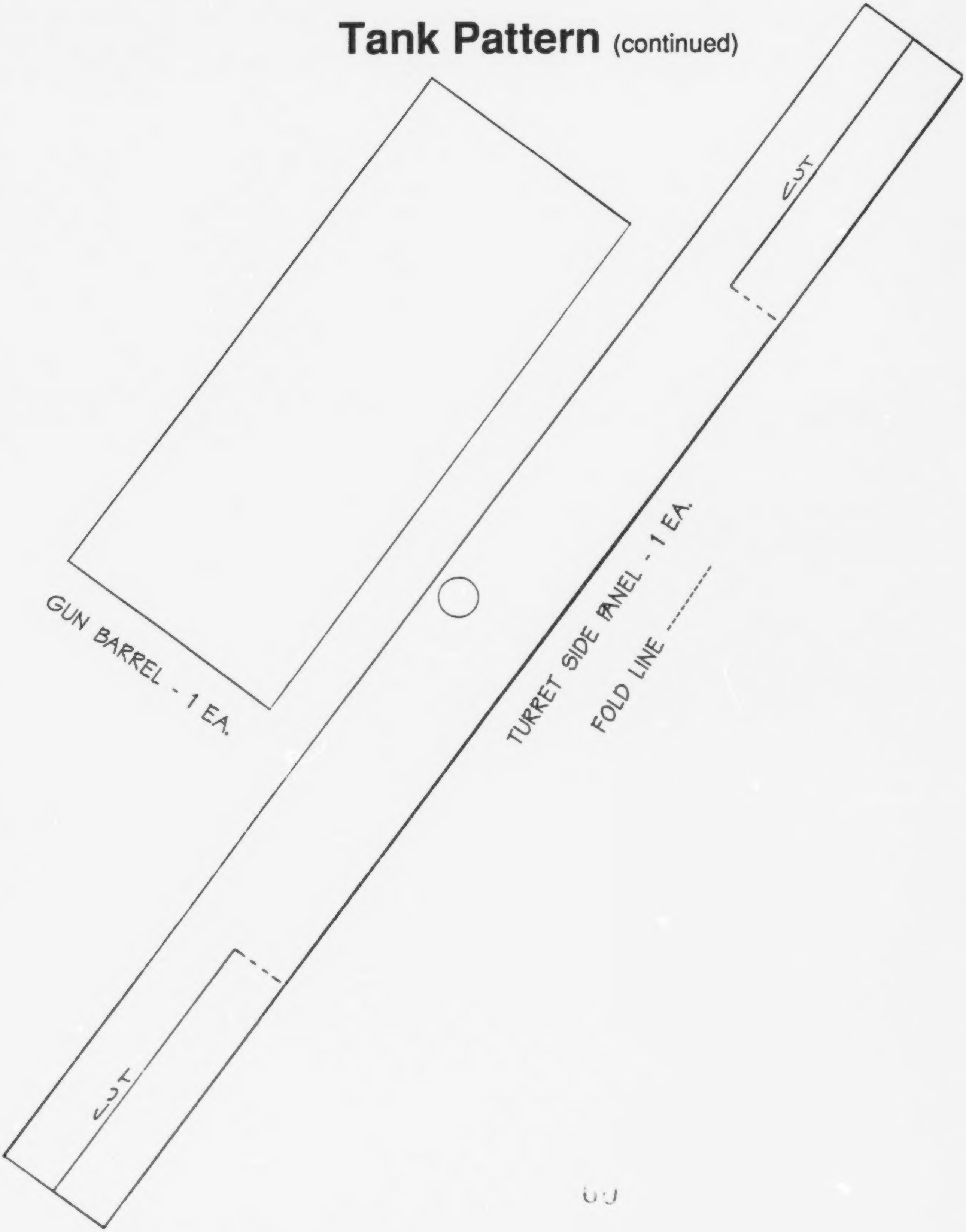
Tank Pattern



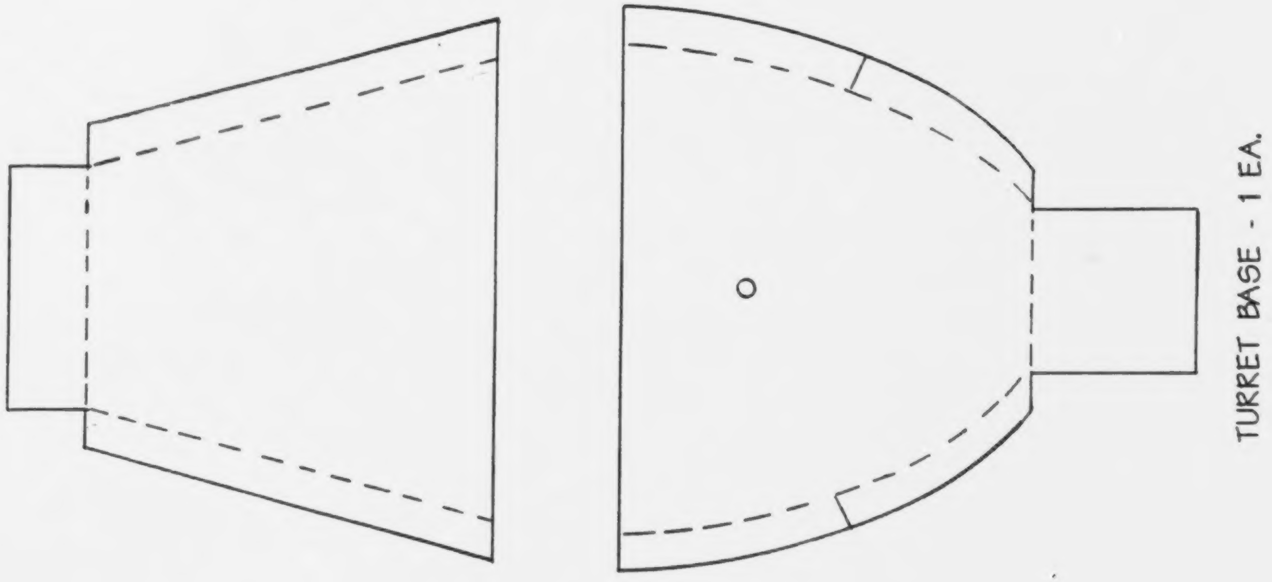
TANK BODY - 1 EA.

FOLD LINE ----------

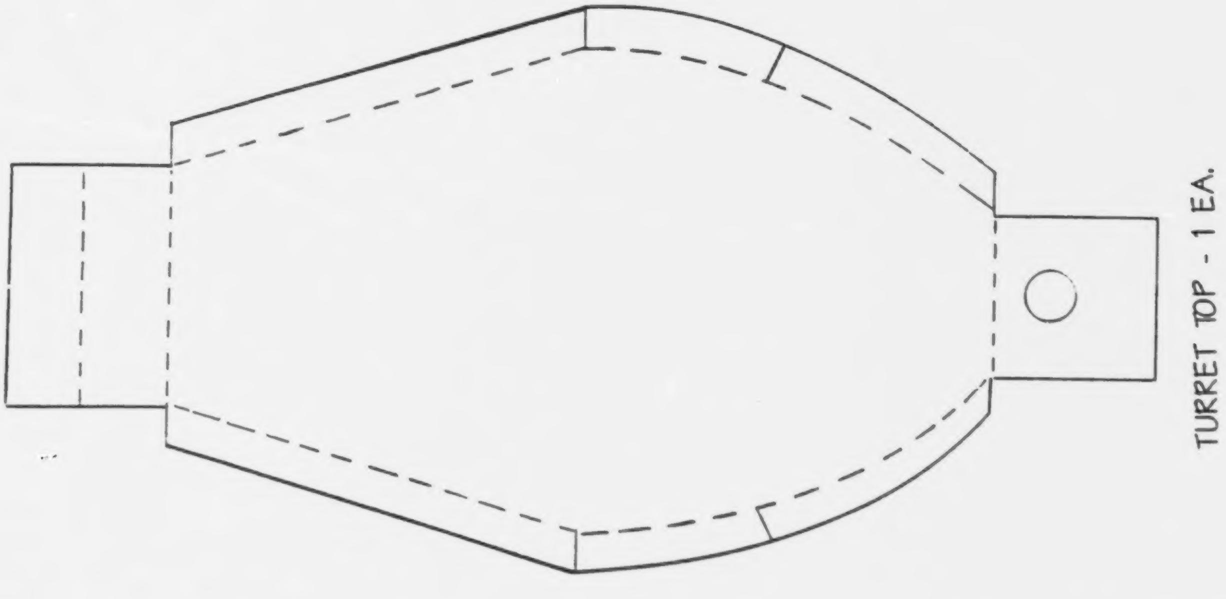
Tank Pattern (continued)



Tank Pattern (continued)

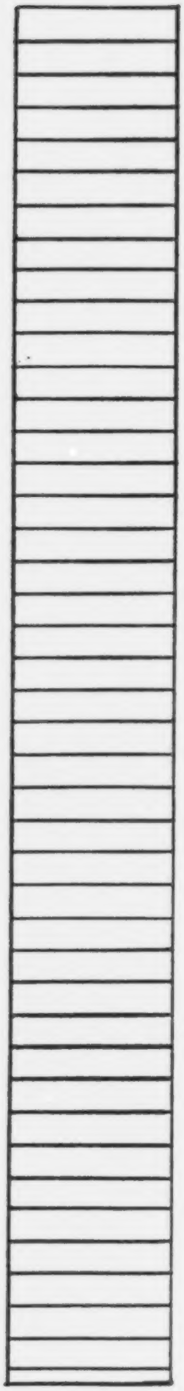


FOLD LINE ----------

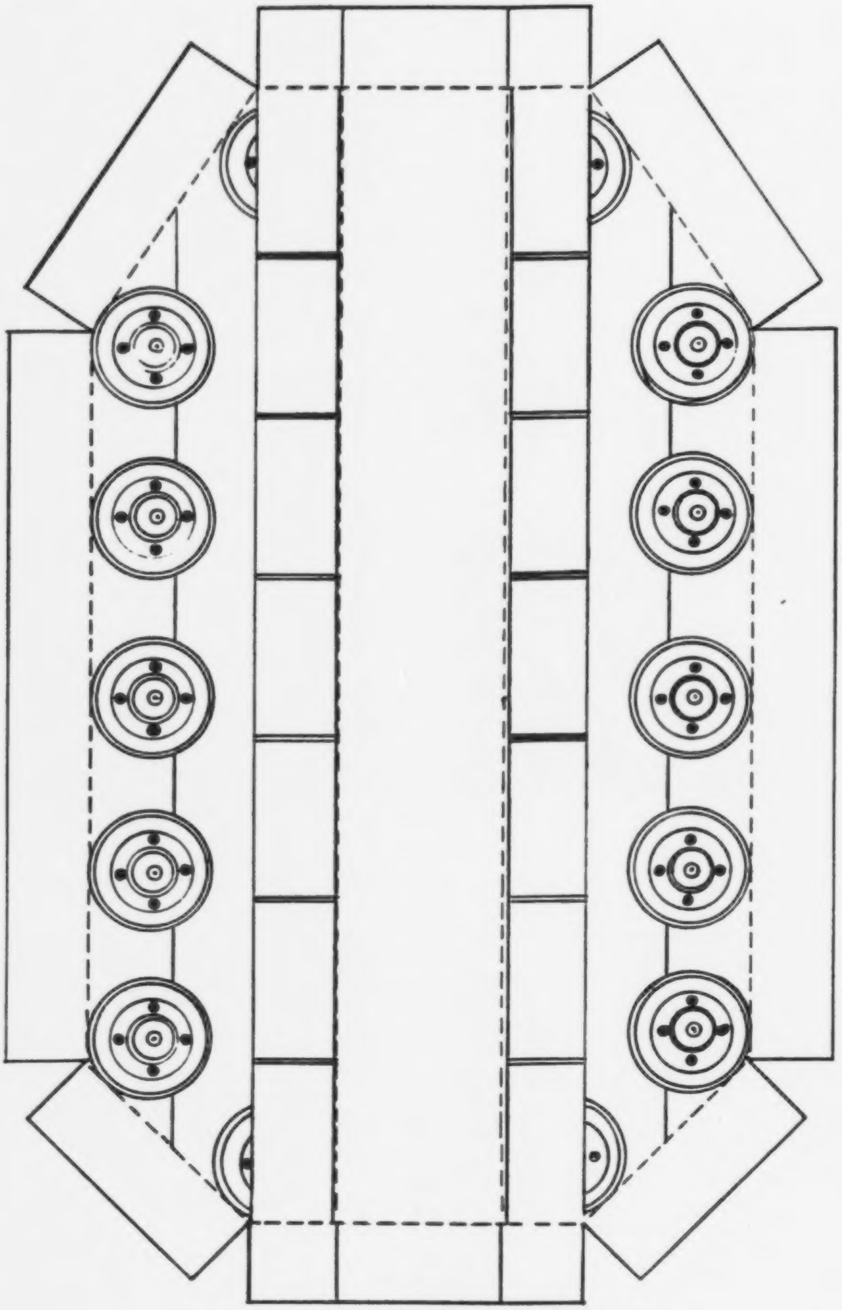


FOLD LINE ----------

Tank Pattern (continued)



TANK TRACK - 2 EA.



TANK WHEEL ASSEMBLY - 2 EA.

FOLD LINE -----------

(4 DAYS)

INTRODUCTION TO INVENTION AND INNOVATION

Essential Elements: 1, 2, 5
TAAS Objectives: Language Arts: RC 1–6, WC 1–7
Mathematics: C 1

Activity Overview

This activity is intended to introduce students to the historical importance of invention. Students will explore some of the important inventions of the past and present and plot them on a time line.

Challenge Statement

Technology students need to understand the importance of invention as it relates to people's need to improve themselves and the world in which they live.

Systems Model

Resources
Background information
Research documents

Processes
Students do research of old and new inventions

Applications
Creativity

Impact
Creativity
Inventions and innovations

Interfacing with Other Disciplines

Language Arts:	Students will research information about past and current inventions, write a report, and plot a time line.
Mathematics:	Students will use chronological time to create a time line.
Science:	Students will use scientific principles to understand various inventions and their uses.
Social Studies:	Students will research past and present inventions and their impact on society. From this information, they will plot a time line.

Critical Thinking Skills Reinforced

Application skills are used to prepare and transfer research information to written reports and time lines. Students will analyze, generalize, and synthesize information to plan and write reports. Students will have the opportunity to extend and consider information through presentations.

Teaching Tips

1. Adjust the time frame to meet the needs of your students.
2. Encourage creative thinking by your students.
3. Discuss the importance of invention and innovation with your students.
4. Arrange for a field trip to a local museum.
5. Arrange for a field trip to a local industry which has a display of their early product line.
6. Arrange for a guest speaker who is familiar with the patent process to talk to your class about invention and inventing.
7. Obtain a video program related to the process of invention and its relationship to problem solving in industry.

Instructional Strategy

Collect and organize current events magazines and articles on new inventions to catch the attention of your students. Stimulate interest and maintain focus by reviewing several current and futuristic inventions reported. Clearly specify instructional expectations for the written report. Use team teaching, where appropriate, in the research process. Evaluate students on presentations of their written reports and their input on the time line.

Equipment/Supplies

1. Teacher-prepared time line (Make it as large as room will allow.)
2. Writing paper
3. Posterboard
4. Pencils and pens

Evaluation Key

Grade the students on the accuracy and neatness of their work. Participation and cooperation are important.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame for your special population, and/or team special-needs students with non-special-needs students. Request a resource person to assist special-needs students. Make all students feel welcome in your class and lab.

INTRODUCTION TO INVENTION AND INNOVATION

Activity Overview
This activity is intended to introduce students to the historical importance of invention. Students will explore some of the important inventions of the past and present and [illegible]

Challenge Statement
Understanding the importance of inventions as they relate to people's need to improve themselves and the world in which they live will give you a better understanding of technology and society. It can also help you solve the needs of society through invention.

Objectives
- To discuss and describe one historically significant invention and how it has impacted our world
- To describe and discuss one modern invention and how it will impact our world
- To discuss how teamwork, problem solving, and creative thinking fit into the invention and innovation system

Vocabulary/Concepts Introduced
- Invention
- Innovation
- Technology

Equipment/Supplies
- Writing paper
- Posterboard
- Pencils and pens

Introduction
The first inventions date back to the time of cave dwellers, some two million years B.C. Early inventions were devices that were tied directly to survival and included tools such as axes, chisels, and weapons like the bow and arrow and the spear. These tools helped people make things, capture game, and protect themselves from wild beasts and other humans. These early inventions, although simple by today's standards, were the results of creative imaginations and helped to solve some of the problems that these people faced. In fact, they were significant contributions to the development of the world as we know it today.

From these early days, people have strived to find new and better ways of doing things. Take a moment to observe your surroundings. You will see a wide variety of gadgets you use on a daily basis. Some of them are easily recognizable, while others may be unknown to you. Electric lights, mini blinds, traffic signals, central air conditioning and heating, pencil sharpeners, ball-point pens, calculators, and

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
   a. Prepare a three- or four-page written report on an invention that dates back at least one hundred years.
   b. Include at least three references in your report.
   c. Create a posterboard drawing that illustrates the development of the invention to accompany your written report.
   d. Be sure that your report addresses both the negative and positive impacts that the invention has had on society.
   e. Present your research project to the entire class and plot the invention on a time line created by your instructor.
2. *Modern invention*
   a. Prepare another three- or four-page written report on an invention that has been developed within the last fifty years.
   b. Create a posterboard drawing to illustrate the development of the invention.
   c. Be sure that your report addresses both the positive and negative impacts that the invention has had on society.

(c) Present your research project to the entire class and play the recording on the [illegible] [illegible] ([illegible]) [illegible]

Evaluation

Your evaluation will be based on your participation in and completion of the [illegible] project.

DIGITAL VIDEO

[illegible] [illegible]
[illegible] [illegible]
Mathematics [illegible]

Activity Overview
This activity is intended to introduce students to the new and emerging technology of digital video. Digital video systems will become a common method for importing video images into a personal computer. This activity will explain how the technology works and can be used.

Challenge Statement
New and emerging technologies that will change the way we currently do things are constantly being developed. It is important for students involved in industrial technology programs to experience as many of these technological devices as practically possible.

Systems Model
[illegible]
Background Information
[illegible]

Process
Observation
Demonstration
Brainstorming
Presentation

Applications
Emerging technology

Impact
Applications to new technology

Interfacing with Other Disciplines

Language Arts:	Students will observe a demonstration, brainstorm applications, and give a presentation of ideas.
Mathematics:	Students will understand the application of numbers in creating a digital video.
Science:	Students will apply the use of digital video to scientific purposes.
Social Studies:	Students will discuss the impact of digital video on different aspects of society.

Critical Thinking Skills Reinforced
Students use application in transferring the information in this activity to their general use. They will make generalizations about the technical information in the unit by brainstorming applications.

for digital video. They will synthesize information to organize and combine the concepts of this technology with others. Evaluation concepts are used to assess application ideas from other groups.

Teaching Tips

1. Arrange for a demonstration of the Video Spigot and Adobe Premiere software programs to your students.
2. Have students write a short technical paper related to how this technology can be used ion a school, e.g., developing instructional multimedia programs.
3. Encourage brainstorming to develop ideas for using the technology.
4. Use technical reference material as needed.
5. If appropriate, have students write a proposal to the school administration for adoption of this computer system for your school.
6. Use technical reference material as needed.
7. If you have the equipment, and you feel your students are able to handle it safely, allow each group to go through the digital video process themselves.

Instructional Strategy

The digital video will catch the interest of your students to introduce the topic with new vocabulary and processes. Encourage students to generalize and extend the process to all areas of technology. If at all possible, allow the students time for hands-on work. Display all end products after the presentations for further evaluation.

Equipment/Supplies

1. Any NuBus Macintosh computer (Macintosh II models)
2. Color monitor with 8-bit or greater graphics card
3. At least 4 Mg RAM (8 Mg recommended)
4. At least 40 Mg hard drive (80 Mg recommended)
5. System 6.0.7 or later
6. 32-bit QuickDraw version 1.2 or later
7. QuickTime version 1.0 or later
8. Video camera and VCR
9. Blank videocassettes

Evaluation Key

Instructor evaluation will be based on students' participation in and completion of the activity and the class presentation.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified to meet the needs of special-population students. It is likely that the activity will be tied to a demonstration by a computer sales representative. You may want to videotape the presentation so that students can review it at a later time.

DIGITAL VIDEO

Activity Overview

This activity is intended to introduce students to the new and emerging technology of digital video. Digital video systems will become a common method for importing video images into a personal computer. This activity will explain how the technology works and can be used.

Challenge Statement

New and emerging technologies that will change the way we currently do things are constantly being developed. It is important for students involved in industrial technology programs to experience as many of these technological devices as practically possible. The development of digital video imaging is one of these new technologies that has the potential to greatly improve the use of computers by allowing us to import video images.

Objectives

- To discuss and describe the basics of digital video imaging
- To describe how video images and computer technologies can be combined

Vocabulary/Concepts Reinforced

- Analog
- Digital
- Frame
- QuickTime

Equipment/Supplies

- Any NuBus Macintosh computer (Macintosh II models)
- Color monitor with 8-bit or greater graphics card
- At least 4 Mg RAM (8 Mg recommended)
- At least 40 Mg hard drive (80 Mg recommended)
- System 6.0.7 or later
- 32-bit QuickDraw version 1.2 or later
- QuickTime version 1.0 or later
- Video camera and VCR
- Blank videocassettes

Introduction

The ways in which people communicate have changed dramatically over the last twenty years. Television technology has finally reached all corners of the world, and the development of easy-to-use video camcorders has contributed even more to the process of communication. The use of personal computers is now following the same path, and they are becoming more common in both office and household settings. Their effectiveness has also brought about the additional development of desktop publishing programs, laser printers, modems, and other very effective communications equipment.

Perhaps the most significant communications technology trend taking place today is combining these two systems. In the past, there have been several attempts to adapt both video and computer technologies into one system, but developers achieved limited success and offered little for the small personal computer user. These two systems work wonders in their own environments, but, because of the processes each uses, they are very difficult to combine into one integrated technology. Basically, the difficulty has been combining a video image, which is *analog data*, with a computer process, which uses *digital data*.

One way to visualize the difference between analog and digital data is to compare two types of watches. A watch with movable hands operates mechanically and is also known as an analog watch. The movement of the hands is tied directly to the movement of the mechanics inside the watch, and the data or time information that the watch communicates is a continuous process; there is a direct relationship between the position of the hand and the time of day. The other type of watch is known as a digital watch. Digital watches use no movable parts and rely on a series of liquid crystals to display time information. As electrical energy is allowed to flow through different crystals, the display numbers change. There is no direct relationship between the crystals and the time because each crystal is used to form several numbers.

Analog video is composed of a stream of electrical signals. The force and the shape of the stream is directly proportional to the image viewed on the screen. Bright images, for instance, require more force than dim images, and the image shape is directly related to the size and shape of the electrical signal on the videotape. Digital images in the computer are created by bits of information that are created with the on-off/yes-no data formation. Typically, one process does not communicate with the other, and to combine the two there must be some way to convert one system to the other.

Because digital data is considered the superior process, the problem of converting analog data into digital data has been difficult. The problem lies in the sheer volume of data that must be handled by the conversion. One frame of analog video data, for instance, requires about 1 MB of digital data. It takes between 25 and 30 frames a second to create a moving video image. The sheer volume of digital data, then, is tremendous. It would take a very powerful computer to handle 30 MB of information every second, well beyond the capacity of most personal computers. Even the top-of-the-line personal computers are not capable of handling this much information this fast. Storage of the converted data is also a problem: a one-minute video movie would require about 1,800 MB of storage space. This volume of data is also well beyond the capacity of most personal computers.

The development of the video digitizer was one of the first attempts at making this integration work. The video digitizer certainly worked to convert video images into digitized data. The problem with this concept was that it required about 20 seconds to complete a single image, making it much too slow for capturing moving images. It did work well, however, for copy work, such as taking pictures of printed photographs or artwork, much like a scanner. Unfortunately, the digitizer was limited to still images.

Several attempts to combine video and computer imaging were made with very little true integration. The sheer size of digital video images continued to be a major stumbling block. Recently, however, a new concept has evolved that helps to solve this problem. It is called "digital image compression." Digital image compression reduces the size of the video image from 1 MB to about 50K, allowing users to store a full minute of video on a 90MB disk. Although compression still requires a substantial amount of storage space, it is an improvement over other processes. Coupled with certain graphics programs such as QuickTime and Premiere, the video image can be edited in the computer with greater options than most analog editing systems will permit. Another advantage of digital video is the ability to make undistorted copies of the video movie. Because the image is digital, there is no loss of quality from one generation to another. Typical analog copies lose some quality from one generation to another.

Procedure

1. Your instructor will arrange for a demonstration of the digital video process. In this demonstration, you will be able to view how and why the system works.
2. After observing the demonstration and discussing this new technology, your instructor will ask each student in the class to develop some type of practical application for which it might be used. Students can either work individually or in small groups, depending on how your instructor wants to organize the activity.
3. Once your group has determined what it considers a good response, you will be asked to present the idea to the rest of the class. Your presentation should include (a) the area of application (military, medicine, education, criminology, etc.), (b) sketches or posters of your application and/or end product, and (c) an explanation of why you think this application is important.

Evaluation

You will be graded on your presentation to the class.

COMPUTER ANIMATION

Essential Elements: 1, 2, 4, 6
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1

Activity Overview
Students will explore the use of computer animation using a personal computer and animation software such as Animation Works.

Challenge Statement
Modern technological advances, computers in particular, have changed the way many traditional technical operations occur. It is important for students enrolled in industrial technology programs to experience as many of these transitional processes as possible. One of these technologies, animation, is certainly being affected by the expanding capabilities of personal computers.

Systems Model
Resources
Background information
Team members

Processes
Teacher demonstration
Brainstorming
Planning
Designing
Storyboarding

Application
Teamwork project
Computer animation

Impact
Animation techniques
Communication

Interfacing with Other Disciplines

Language Arts:	Students will observe a demonstration, brainstorm applications, and give a presentation of ideas.
Mathematics:	Students will understand the application of numbers in creating computer animation.
Science:	Students will apply the use of animation to scientific purposes.
Social Studies:	Students will discuss the impact of animation on different aspects of society.

Critical Thinking Skills Reinforced

Students will apply the design loop to the planning and design needed for this activity. Students will analyze and synthesize information in both the design and production of the animation. Evaluation concepts are used in a follow-up discussion of the completed animation programs and their application to various areas of technology.

Teaching Tips

1. Demonstrate the correct use of the software to students.
2. Use this activity as either an individual or small-group (two or three students) project.
3. It is likely that you will only have equipment for one group to work on this activity at a time. It is advisable to have a quiet area of your lab set aside for them to work without distraction.
4. If you have equipment for only one group, plan applicable activities for the remainder of the class during their time away from the computer.
5. Do not allow students to use the program master disks. Working copies should be made in accordance with software restrictions and put away for safekeeping.
6. Before introducing this activity to students, you can develop several examples to use for demonstration.
7. Assemble a student resource manual that they can use while working on their project.

Instructional Strategy

Animation will focus the attention of your students on the project. Be sure that all materials and equipment are organized at the start of the unit. Check for understanding of terms and concepts throughout the unit and reteach if necessary. Monitor each group for 100-percent participation by the group. The class will participate in the evaluation through viewing the final animation from each group.

Equipment/Supplies

1. Any color Macintosh computer using System 6.0.5 or higher with QuickDraw 1.2 for color Macintoshes with a hard drive and at least 2 MB of RAM
2. Drawing paper
3. Pencils
4. Blank computer disks

Evaluation Key

Evaluation will be based on student participation in and completion of the activity. Additional instructor evaluation can be given as necessary.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can serve special-needs students very well. It is relatively easy to use and should serve to motivate them to be creative and successful. Modification of the activity to meet specific needs can be accomplished by teaming special-needs students with non-special-needs students. Additionally, a resource person can be requested from the special education department to work one-on-one with special-needs students.

COMPUTER ANIMATION

Activity Overview

Students will explore the use of computer animation using a personal computer and animation software such as Animation Works.

Challenge Statement

Modern technological advances, computers in particular, have changed the way many traditional technical operations occur. It is important for students enrolled in industrial technology programs to experience as many of these transitional processes as possible. One of these technologies, animation, is certainly being affected by the expanding capabilities of personal computers.

Objectives

- To use a personal computer
- To use a computer animation program to create a short animation movie

Vocabulary/Concepts Reinforced

- Animation
- Background editor
- Cel
- Cel editor
- Events
- Movie editor
- Registration

Equipment/Supplies

- Any color Macintosh computer using System 6.0.5 or higher with QuickDraw 1.2 for color Macintoshes with a hard drive and at least 2 MB of RAM
- Drawing paper
- Pencils
- Blank computer disks

Introduction

The history of animation dates back to about 2000 B.C., when Egyptian artists created images of two wrestlers in a sequence of drawings on a wall mural to illustrate their activity. Animation as we know it, however, only dates back to about 1923, when Walt Disney organized the first animation studio in Hollywood, California. By 1928 he had produced his first animated cartoon featuring Mickey Mouse and created the basis for a technology that would grow to become one of the most successful entertainment industries in the world.

Although we generally associate animation with cartoon characters like Mickey Mouse and Fred Flintstone, we often forget about its other applications. Animation techniques are often used in education and training films. The military learned the value of animation techniques early in the development of training films. Both education and industry also have relied on animation techniques to create effective training and education programs.

Procedure

1. Your instructor will demonstrate the animation software Animation Works. Pay close attention to its operation and basic techniques.
2. After observing the demonstration, your instructor will divide the class into small groups of two or three students. Each group will plan and produce an animated movie of at least one minute.
3. When your group finishes its animation production, you will be asked to present it to the entire class.

Evaluation

Instructor evaluation will be based on your participation in and completion of the activity. Additional evaluation criteria may be established by your instructor as needed.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 9
(1–2 WEEKS)

SOLUTIONS TO PROBLEMS CREATED BY MODERN TECHNOLOGY

Essential Elements: 1, 2, 4, 5, 7, 8, 12, 14
TAAS Objectives: Language Arts: RC 1–6; WC 1–7

Activity Overview

This activity is designed to tie technological systems to global and social issues. Students will identify a variety of world problems, choose one of the specified problems, and develop alternative technological solutions for the problem. Finally, students will model one solution in an attempt to "repair the world."

Challenge Statement

Sensitivity to world problems is an important element of technology education. Although students may be exposed to the impacts of technology on global and social issues, they probably have not been given an opportunity to creatively think through alternate technological solutions. This activity will provide students an avenue to develop simulated alternative technological solutions to some of these problems.

Systems Model

Resources
Team members
Materials
Tools and equipment
Background information

Processes
Determine the system needed to solve a global or social technological problem.

Applications
Group activity
Creative thinking skills
Technological problems

Impact
Teamwork
Problem solving
Industry

Interfacing with Other Disciplines

Language Arts: Students will research information about past and current technological problems, brainstorm solutions, write a report, and present solutions to the class.

Mathematics: Students will use math to analyze a problem and determine a solution. They will review a time line.

Science:	Students will use scientific principles to understand various technological problems.
Social Studies:	Students will research information about past and present technologies and their impact on society. They will extend this information to solutions.

Critical Thinking Skills Reinforced

Students will apply given information and transform resources to identify a technical problem. They will analyze, differentiate, discriminate, distinguish, extend, and generalize information they research from various areas of interest. Students will synthesize the information to compose a technical paper, create alternative solutions, and develop a simulation to model their solutions. The entire class will assess the solutions of each team through group discussions.

Teaching Tips

1. Encourage students to think about global technological issues that are real concerns. Modern technology has affected the environment in many ways, including air and water pollution, waste disposal, deforestation, depletion of the ozone layer, etc. Some of these concerns may have significant local importance.
2. Encourage your students to look carefully at both sides of an issue. Many of these concerns have become extremely sensitive political issues and have strong supporters on both sides. Encourage the use of brainstorming.
3. Have your school librarian review research procedures and the use of the school library. Use various media resources as available.
4. Obtain a technology time line and create a bulletin board display that helps illustrate events in modern technology.
5. This activity can be used as a small-group project or as an individual project.

Instructional Strategy

Use group discussion and lecture to present the topic to students. Use various media resources as available to make the information more interesting and applicable. Emphasize the importance of such an exercise in making the world better for everyone. Encourage the use of brainstorming without criticism. Make frequent checks of student progress and encourage them to stay focused and on task. Evaluate your students through presentation and discussion of solution ideas.

Equipment/Supplies

1. Various tools and equipment will be needed for students to fabricate their simulation models.
2. Materials will vary according to the needs of the students' solution to a given problem.
3. A personal computer with word-processing capability should also be available for students to assemble their written documentation.

Evaluation Key

Instructor evaluation of this activity should be based on student's participation in and completion of the project. Students will be required to write a short technical paper to accompany their model. They will also be required to present their model to the entire class and participate in a class discussion of technological impacts.

Modifications for Handicapped, Disadvantaged, and LEP Students

Ask that a resource person be made available to help you with special-needs students. When possible, arrange to have students with similar handicaps assigned to the same class. Use the "buddy system" by teaming special-needs students with non-special-needs students. Check each student's permanent record for ways to handle special problems.

SOLUTIONS TO PROBLEMS CREATED BY MODERN TECHNOLOGY

Activity Overview
Students will review several of modern technology's impacts on society. They may be environmental issues such as air and water pollution, or social issues such as loss of human jobs to robotics. Students will select an issue, research cause-and-effect information, then work to create a simulated model that they will present to the class as a solution to the problem.

Challenge Statement
Modern technology has provided us with many important discoveries. In most cases they have served us well by making us more productive and efficient in the ways in which we live and work. On the other hand, modern technology has also created a variety of negative effects on our lives. It is important for you to learn to balance both the positive and negative aspects of modern technology and to realize that some technological advances will have negative impacts.

Objectives
- To explain why selected technological impacts affect global, national, and local social issues
- To identify technological resources needed to implement solutions to these impacts
- To model a solution for a given problem using resources in the school library

Vocabulary/Concepts Reinforced
- Technology
- Negative impacts
- Positive impacts

Equipment/Supplies
- Various tools and equipment will be needed to fabricate your simulation models.
- Materials will vary according to the needs of your solution to a given problem.
- A personal computer with word-processing capability will also be available for you to assemble your written documentation.

Introduction
This activity is intended to help students develop a better understanding of modern technology and how it impacts both our society and the rest of the world. The many technological advances that we have made over the last one hundred years are staggering. They represent the imagination, creativity, hard work, and determination of a great many men and women who have dedicated their lives to discovering new and better ways of doing things.

Along with the many advantages of new technology, however, are the negative effects that often accompany them. For example, look at the evolution of the automobile. Basically, the automobile was developed because people wanted a more efficient means of transportation. The development of the automobile coupled with the assembly line and mass production led to our country being covered with a complex system of interstate highways, freeways, city streets, and paved rural roadways. Our nation and many others became obsessed with private automobiles and the freedom of personal travel.

Although the automobile represents a great technological achievement, it has also created several negative impacts. One of these impacts is safety. In this country alone there are in excess of 50,000 traffic-related deaths each year and many more thousands of injuries directly related to traffic accidents. The costs of personal loss and property damage are staggering, not to mention the ugly piles of junked cars that accumulate outside our cities and towns. It is safe to say that we have all experienced both the positive and negative effects of modern automobile technology.

To help improve the safety of the automobile, automotive designers have worked hard to make them safer for the driver and his or her passengers. They have improved materials, handling characteristics, tires, brakes, safety restraints such as seat belts and shoulder harnesses, and others. One of the most recent safety devices to be developed is the air bag, which may prove to be a very significant development for the automotive industry. These improvements serve to offset the negative effects created by modern technology and are part of a continuing process called progress.

Procedure

1. Your instructor will lead a discussion of several of the major technological issues and concerns. He or she will discuss some of the underlying positive and negative effects that are characteristic of these technological issues.
2. Working independently or in small groups, brainstorm to identify other technological issues that may have positive and negative impacts. Make a list of these, and discuss them with your instructor. Categorize your findings into the following areas:
   - Biotechnologies
   - Transportation
   - Energy
   - Communication
   - Manufacturing
   - Construction
3. Your instructor will schedule your class to go to the library to research additional information. Try to find at least one example to illustrate each of the categories listed above.
4. In a class discussion of the topic, your instructor will compile a master list of technological developments for each of the categories above with a set of both positive and negative effects.
5. Working independently or in a small group, your task is to develop a simulated model which will illustrate your solution to one of the negative impacts of a particular technology. This simulation model can be a low-relief model that might illustrate basic mechanical movement or a three-dimensional model used to illustrate a scaled version of a larger or smaller device. Your model should be completed and presented to the class as a solution to solving a negative technological impact.

6. In addition to the model, prepare a short technical paper in which you identify a particular technological impact and explain how your model will serve as a possible solution.

Evaluation

Instructor evaluation of student performance will be based on your participation in the class discussions and completion of the simulation model and accompanying technical paper.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 10
(5–10 DAYS)

SHARING TECHNOLOGY

Essential Elements: 1, 2
TAAS Objectives: Language Arts: RC 1–6

Activity Overview

This activity is designed to provide students with the knowledge and information needed to understand and control one of the oldest forms of technology, fire. In this activity students will learn to generate fire through a number of sources. Students will also learn the responsibility and safety concepts needed to properly use fire to cook, keep warm, and light an area. They will construct a device that can generate fire, and if possible, test their device under the supervision of the instructor. They will also become familiar with the four different types of fire extinguishers and their intended uses.

Challenge Statement

It is important for students to develop an understanding of what technology is and why it exists. One of the earliest forms of technology was fire. Its use certainly improved the conditions under which people lived during that period and possibly was the beginning of technology as we know it today.

Systems Model

Resources
Materials
Tools and equipment
Background information

Processes
Designing
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Problem-solving activities

Impact
The development of technology

Interfacing with Other Disciplines

Language Arts: Students will list technical fire-starting devices and materials necessary to construct such devices.

Science: Students will use scientific principles of thermodynamics, heat energy, and combustion to understand reusable, technological, fire-starting devices.

Social Studies: Students will imagine past and present technologies related to fire and their impact on society.

Critical Thinking Skills Reinforced

Students use creativity and imagination to design reusable, technological, fire-starting devices. They will have the opportunity to test and redesign the devices before demonstration and evaluation.

Teaching Tips

1. Use this activity as either a small-group or individual project.
2. Ensure safe handling of materials and equipment.
3. Review safety procedures for handling flammable materials.
4. Check with school district policies that might affect the use of this activity with students.
5. Encourage creative thinking and exchange among your students.
6. It would be desirable to have students complete a short technical paper in which they summarize their work and findings.

Instructional Strategy

Use the discussion/lecture method to present the topic to students. Demonstrate various aspects of the activity to students as needed. Monitor students continually for safety and provide corrective feedback immediately. Have all materials organized in advance to maximize time. Evaluate students based on their presentations and written materials.

Equipment/Supplies

1. Magnifying lens
2. Parabolic reflector
3. Assorted hand tools
4. Metal-covered test area for safety
5. Fire extinguisher

Evaluation Key

Instructor evaluation should be based on student participation in and completion of the activity. Instructors may wish to assign a short written summary paper in which students describe the processes that they performed.

Modifications for Handicapped, Disadvantaged, and LEP Students

1. Use the "buddy system" to team special-needs students with non-special-needs students.
2. A resource person can be made available to help with this activity as needed.
3. If you feel that this activity is too hazardous for special-needs students, they can be assigned special tasks that will still keep them involved in the project.

SHARING TECHNOLOGY

Activity Overview

This activity is designed to provide students with the knowledge and information needed to understand and control one of the oldest forms of technology. In this activity students will learn to generate fire through a number of sources. Students will also learn the responsibility and safety concepts needed to properly use fire to cook, keep warm, and light an area. They will construct a device that can generate fire, and if possible, test their device under the supervision of the instructor. They will also become familiar with the four different types of fire extinguishers and their intended uses.

Challenge Statement

It is important for students to develop an understanding of what technology is and why it exists. One of the earliest forms of technology was fire. Its use certainly improved the conditions under which people lived during that period and possibly was the beginning of technology as we know it today.

Objectives

- To list examples of bio-related technology
- To list changes in your daily routines that have resulted from the use of technology and technological devices
- To safely use material and equipment in the lab to produce and control fire

Vocabulary/Concepts Reinforced

- How people use technology to extend their capabilities and to lead a better life
- The importance of choosing proper resources for technology
- The responsibility all people must have when using technology so that control of the technology is made possible
- Human interaction with technology systems
- Fire safety and training

Equipment/Supplies

- Magnifying lens
- Parabolic reflector
- Assorted hand tools
- Metal-covered test area for safety
- Fire extinguisher

Introduction

Have you ever considered what your life would be like if technology did not exist? Think for a few seconds how hard life was for people in early times who did not have the technological innovations that you use every day. Work, communication, travel, and other aspects of life were difficult to complete. Humans during the course of history have invented technical devices and processes to make their work and lives easier. These inventions are improved as technology advances.

One of the earliest forms of technology was fire. It changed the way people lived in prehistoric times. They found that fire would heat and light the inside of their caves, making them warmer and more comfortable. They soon discovered that they could cook food using fire, a technological application responsible for our passion for barbecued ribs. They also found that fire could help them make weapons and turn soft clay pots into pottery. The use of fire has affected many of the ways in which people live and work. Fire, or combustion, is the basis of many of the industrial processes and generation of energy that we use today. Even the microwave oven that you and your family may use at home has its roots in the technology of heat energy.

As with any technology, there are both positive and negative effects of heat energy in terms of "controlled" or "uncontrolled" use of fire. Uncontrolled fires result in millions of dollars in property damage and great loss of life each year. Working with heat energy is serious business and should be approached carefully.

One of the difficulties associated with heat energy is finding a good method to start it. Early people probably had to wait for lightning to strike a tree before they had a chance to gather enough flaming branches to take back into their caves. Although lightning worked, it wasn't always available. Herein lies one of people's first encounters with developing technology: how to make fire themselves. Initially, once they got a fire started they had to keep it going. When they moved from place to place, it was important for someone in the group to be sure to pack enough hot coals in moss and wrapped with skins to ensure that they had enough heat to start a fire at their next location. Keeping the fire going probably earned a place as a ritual among cave dwellers.

Three conditions are necessary to make fire: (1) there must be some type of material to burn, or *fuel*; (2) there must be a *kindling temperature*, which is the temperature at which oxygen will rapidly unite with the fuel; and (3) there must be plenty of *oxygen*. These three conditions must be combined to form fire. Removing any of these will cause a fire to stop.

Procedure

For the purposes of this activity you will simulate the role of "Technology Man" or "Technology Woman," a modern person who has traveled in a time machine all the way back to prehistoric time, when people didn't know how to start a fire. Your task is to show the cave dwellers how to make a fire using some of the ideas or items that you have taken back with you. These can include whatever you think you might need, with the exception of matches, cigarette lighters, or any other items that can be used up or run out of fuel. The items that you take with you should be things that the cave dweller will be able to use for a long time.

Design and construct a device or system that will generate fire. This device or system must be safe and controllable. The flame produced should be no larger than that of a standard kitchen match or mechanical cigarette lighter. You will need to also note the impacts that your device or system may have had on an early society. You will first need to sketch out several designs for your device, and then choose the resources that will be needed to produce it. If your device or system is complex, you may wish to work with a partner or small group of students. Follow the basic outline below:

1. List as many types of technical devices or systems you can think of that humans use to generate fire.
2. Decide what type of fire-generating system you would like to work with.
3. Sketch a few basic designs for your pyrotechnic device.
4. Show your design ideas to your instructor. He or she will approve or make recommendations for modifying your device.
5. List the materials that you will need to fabricate the device.
6. Your instructor will demonstrate the proper use of fire extinguishers and discuss which type of fire extinguisher should be used on different types of fires.
7. Test your device to determine whether it works properly. If it does not, modify and improve it until it works correctly.

Evaluation

Instructor evaluation of student performance will be based on participation in and completion of the activity. Your instructor may wish to assign additional evaluation elements as necessary.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 11
(1 WEEK)

TELEvision COMMUNICATION

Essential Elements: 5, 14
TAAS Objectives: Language Arts: RC 1–6; WC 5–7

Activity Overview

This activity will introduce the topic of telecommunication. The students will work in groups to develop television commercials to promote a product or school activity. Students will fill various roles to complete the assignment: director, actor/actress, camera operator, technician, and cue card manager. Alternative activities are suggested for schools without video equipment.

Challenge Statement

Any basic instruction related to the various systems of technology should include a variety of group activities, including telecommunication.

Systems Model

Resources
Background information
Team members
Video equipment

Processes
Brainstorming
Planning shots
Handling equipment

Applications
Exploration of a communication system

Impact
Understanding teamwork and the impact of television as a communication medium

Interfacing with Other Disciplines

Language Arts: Students will research information about telecommunication, brainstorm a script for a commercial, and present the commercial to the class.
Mathematics: Students may use math to design and construct props and sets for their commercials.
Social Studies: Students will discuss issues involving telecommunication and its impact on society. They will extend this information into written and recorded commercials.

Critical Thinking Skills Reinforced

Students will apply information about telecommunication in preparing a written worksheet, quiz, and video production. Analysis and synthesis are used in extension of information and rearrangement of ideas through the video production. Students and the instructor will evaluate understanding of the concepts presented in this activity through observation and discussion of the commercials.

Teaching Tips

1. Introduce the activity by explaining what is expected of the students and set the limitations you desire (e.g., length of commercial, topics that are acceptable, etc.).
2. This assignment can be used as is or adapted in several ways. First, if time permits, allow the students to rotate through the different jobs so that everyone has a chance to be the star, director, etc.
3. As soon as one group is ready to film, let them get started so that all groups of students are not waiting for the camera at once.
4. Another way to schedule camera time for final commercial filming would be to have students come in before or stay after school to ensure a "quiet studio" and no pirating of ideas by other groups.
5. If video equipment is not available, change this to a radio assignment and use a tape recorder to tape radio commercials.
6. Another twist that you could put on this assignment is to integrate this assignment with the mass-production manufacturing assignment and have the students sell the product made by the class.
7. The best commercial representing the product could receive a special prize in addition to a grade.

Instructional Strategy

Begin the module by providing new information to the students and leading a discussion of the social issues involved. State what is expected of the students and set the limits to accommodate your facilities and equipment. Provide the students the necessary work time to meet their expectations and yours. Encourage all students to participate through positive feedback. The completed commercial will provide the evaluation tool.

Equipment/Supplies*

1. Video camera
2. Video recording unit
3. Videotapes
4. Lights
5. Backdrop
6. Props
7. Newsprint
8. Masking tape
9. Costumes
10. Television monitor

*See Teaching Tip 5 for exceptions.

Evaluation Key

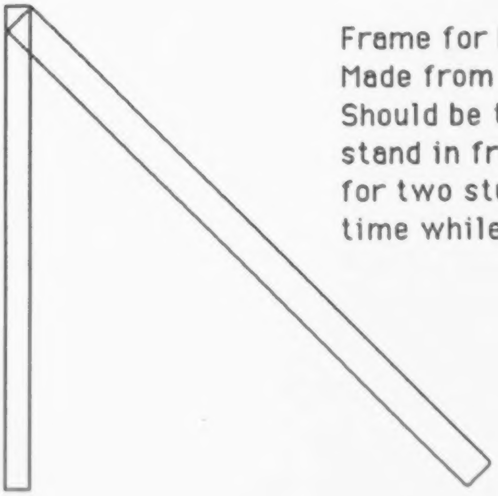
Students should receive a daily grade for their input into the progress of the group. Group grades will be given for the script and the final product. Also, the quiz may be used as an object grade for your students. Another possible assessment tool would be to have other students rate their peers or use a local grade school or middle school for a test audience.

Answers to Quiz

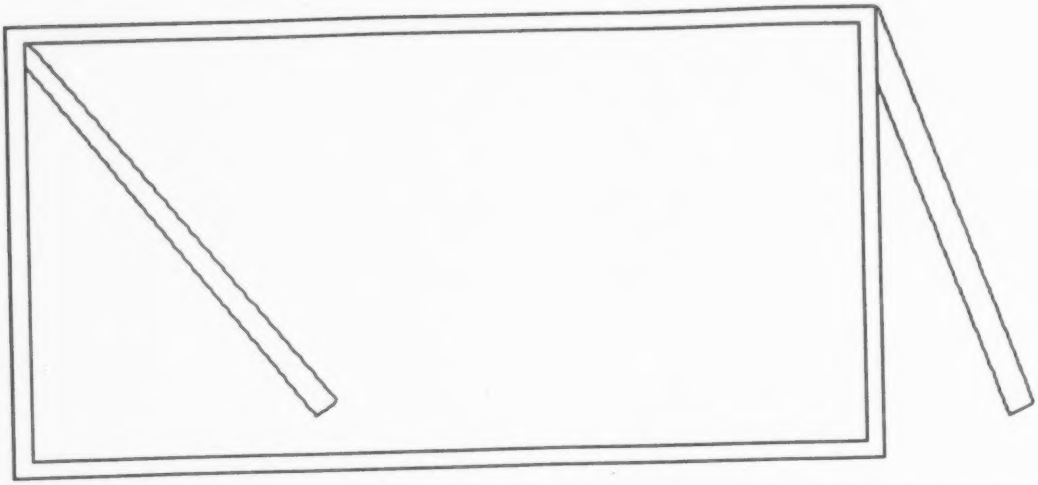
1. List three types of telecommunication:
    1. Voice
    2. Data
    3. Image
2. List three social and/or environmental concerns about telecommunication:
    1. Overcrowding in outer space
    2. Instant news coverage of tragedy
    3. TV violence causing real violence

    (Accept any others discussed in class.)
3. List five careers that could be pursued in telecommunication:
    1. Director
    2. Actor/actress
    3. Camera operator
    4. Technician
    5. News correspondent

    (Accept any that were discussed in class or those that are obviously correct. Do not allow duplication, e.g., soap opera actress and situation comedy actress.)
4. Describe the job responsibilities for two of the careers listed above:
    (Answers will vary.)



Frame for backdrops.
Made from 1x2 or 2x4
Should be tall enough for students to stand in front of; should be wide enough for two students to be in front of at one time while engaged in filming activity.



Various fabrics can be draped over the backdrop frame to provide different backgrounds. The backdrop frame is not essential for the successful implementation of this unit.

Support Materials

Jones, Ronald E., and Janet L. Robb. *Discovering Technology: Communication.* Orlando, Florida: Harcourt Brace Jovanovich, 1986.

Fales, James F., Vincent F. Kuetemeyer, and Sharon K. Brusic. *Technology: Today and Tomorrow.* Mission Hills, California: Glencoe/McGraw-Hill, 1992.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of your special-needs students by planned grouping and task assignments.

TELEvision COMMUNICATION

Activity Overview

You will work in groups to develop television commercials to promote a product or school activity. Students will fill various roles to complete the assignment: director, actor/actress, camera operator, technician, and cue card manager. Written and radio ads are suggested for schools without video equipment.

Challenge Statement

Telecommunication is a big word describing activities you participate in every day, like watching TV and talking on the phone. Through this activity, you are going to have the opportunity to participate in the creative side of telecommunication.

Objectives

- To better understand the wide use of telecommunication
- To create a telecommunication message
- To understand the value of teamwork

Vocabulary/Concepts Reinforced

- Telecommunication
- Director
- Actor/actress
- Camera operator
- Technician
- Cue card manager
- Oral communication
- Written communication

Equipment/Supplies

- Video camera
- Video recording unit
- Videotapes
- Lights
- Backdrop
- Props
- Newsprint
- Masking tape
- Costumes
- Television monitor

Introduction

How much time do you spend watching television? How much attention do you pay to the messages? Are you aware of the process that takes place before the picture appears on the screen? This learning activity will allow you to create your own message to share with your classmates over the airwaves. You will have direct control over what you see on the classroom "TV station."

Telecommunication is the sending and receiving of messages over long distances. Devices commonly used for this purpose are the telephone, radio, television, and satellites. Voice, image, and data are all transmitted from one site to another via cable or wave transmission. Cable or optic fibers are used for telephone conversations, computer data transfer, cable TV, and local television stations. The use of microwaves to transmit information is a new use of technology. Antennae are used to help send and receive information. Satellite dishes are another common receiver of information. Printed material, voice, and visual images can all be transmitted through satellites to anywhere in the world that has a satellite receiver.

Sporting events, such as the Olympics, can be seen live, even though they take place halfway around the world. International events in politics, the arts, sports, religion, and other areas of life can be seen instantly via telecommunication. This brings up some social issues that should be addressed. Consider this situation, for example: As a war correspondent shows video images of the battlefield, a family in the United States watches as their son lies wounded or dead in the background. They have not received any notification from the government about this incident and are shockingly made aware of a personal tragedy through the impersonal medium of television. Can or should this be prevented? In June 1968, when Senator Robert F. Kennedy was shot in a hotel in Los Angeles, millions of people watched as it happened. Another more recent tragedy that took place while millions were watching was the Challenger space shuttle explosion that killed seven astronauts. Should the broadcast of events such as these be delayed by an hour or so to keep people from having to see them as they happen?

Other concerns should be discussed. Do viewers become violent after watching violent television shows and movies? Can viewers damage their eyes from long hours of exposure to television screens? What about environmental impacts? Is the environment being ruined by cables being strung about neighborhoods and satellite dishes being set up in yards? The satellites themselves can cause problems in outer space. How many is too many? Is it when they reach the point of crowding the orbit space around the earth? These concerns will not be solved during a classroom discussion, but awareness of problems caused by technology can help lead to their solutions.

There are many careers that one can pursue in the telecommunication field. Several are introduced in this unit, including the director, actor/actress, technician, cue card manager, and camera operator. Other positions—all relating to television, telephone, microwave, satellite, or radio communication—include technician, installer, repair person, public relations professional, research and development support, radio or TV personality, news or show writer, sales representative (of commercial time), clerical support staff, and market researchers. Varying levels of education are required for these positions. For the technical/technician positions, a minimal requirement is a degree from a technical school. Public relations, research and development, writing, and market research positions require a four-year college degree. Radio and TV personalities many times do not have advanced degrees, but they help in most cases.

Procedure

1. Research telecommunication background material.
2. Complete the worksheet on telecommunication.
3. Discuss different job descriptions to be used in the assignment with your instructor.
4. Get limitations on product ideas and commercial length from your instructor.
5. Work in groups to develop ideas, write scripts, gather props, make cue cards, rehearse your commercial, and videotape it.
6. Present your commercial to classmates. Evaluation forms will be completed by both your instructor and classmates.

Evaluation

Submit final scripts and group projects to your instructor.

QUIZ

1. List three types of telecommunication.

    1.____

    2.____

    3.____

2. List three social and/or environmental concerns about telecommunication

    1.____

    2.____

    3.____

3. List five careers that could be pursued in telecommunications.

    1.____

    2.____

    3.____

    4.____

    5.____

4. Describe the job responsibilities for two of the careers listed above.

    1.____

    ____

    ____

    ____

    2.____

    ____

    ____

    ____

TELECOMMUNICATION WORKSHEET

Review

Telecommunication is ____

____

These three types of communication are sent via telecommunication processes:

1. ____
2. ____
3. ____

List five careers that are part of the telecommunication industry.

1. ____
2. ____
3. ____
4. ____
5. ____

Television Activity

Lights! Camera! Action!!! In this assignment, you will have the opportunity to create your own television commercial. The script will have to be developed, the stars cast in their roles, the props created, the lights set, and the footage shot. Your instructor will provide you with topics.

Your topic: ____

Time limitations for the commercial: __________ seconds

Following are the different jobs that will need to be completed. Descriptions for each person's duties will be discussed in class. You will need to write down the important information for each role.

Job Descriptions

Director: ____

Actor/Actress:

Camera Operator:

Technician:

Cue Card Manager:

EVALUATION FORM

Answer *yes* or *no* to the following questions.

1. Is the script within the limits set by the teacher? ____________
2. Is the commercial within the time limits? ____________
3. Did the director fulfill his or her role and provide direction? ____________
4. Did the actor/actress "sell" the product? ____________
5. Did the technician set the stage and lighting correctly? ____________
6. Did the camera operator follow cues and operate camera correctly? ____________
7. Did the cue card manager complete his or her task properly? ____________
8. Message of commercial:

   Appropriate to topic limits? ____________

   Clear and concise? ____________

   Does not stray from topic? ____________

   Appealing? ____________
9. Overall impact of commercial:

   Answer *good*, *average*, or *poor*. ____________

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 12
(2–3 DAYS)

MODERN TELECOMMUNICATION

Essential Elements: 5, 6, 12
TAAS Objectives: Language Arts: RC 1–6; WC 1–7

Activity Overview

Students will use a personal computer and a modem to communicate with students using similar equipment at another location.

Challenge Statement

Communication technology is a rapidly changing process. The development of modern equipment such as cellular telephones, fax machines, computer modems, and digital video products are changing the ways in which we communicate with each other. It is important for teachers of industrial technology to provide students with as much basic contact with these systems as possible. Although providing hands-on contact with each of these systems may be difficult for most of us, there are ways to borrow equipment for demonstration.

Systems Model

Resources
Materials
Equipment
Background information

Processes
Message design
Equipment handling
Message transmission and receiving

Applications
Discovery of modern communications equipment

Impact
Understanding telecommunication systems

Interfacing with Other Disciplines

Language Arts: Students will observe demonstrations involving the transmission of written communication. They may write a brief technical paper.
Mathematics: Students will use layout and design to create a written message.
Science: Students will understand the electrical and mechanical operations of computers and other communication equipment and their interrelationship to waves and signals.
Social Studies: Students will discuss issues involving telecommunication and their impact on society. They will extend this information into written and transmitted messages.

Critical Thinking Skills Reinforced

Students will apply information in preparing and demonstrating the use of telecommunication equipment. They will analyze how telecommunication equipment can affect the communication process and society. Students will also be able to see the underlying ideas that are the basis of modern telecommunication put to work in real-life situations. They will synthesize information in creating, transmitting, receiving, and decoding telecommunication messages. Students will evaluate themselves in the preparation and completion of a simple technical paper.

Teaching Tips

1. Arrange to set up personal computers and modems linking your school and another school. If the equipment is not available to you, check with a local computer sales company or educational sales representative to arrange either a demonstration or a loan of the equipment that you need.
2. Discuss with your students the ever-changing world of telecommunication technology. Discuss with them the systems being used, as well as the impacts that they have on the effectiveness of communication.
3. If possible, include software and equipment such as a scanner to digitize images or messages that can be transmitted and received by the two schools' computer stations.

Instructional Strategy

Use demonstration and group discussion to present the topic to students. Demonstrate the proper use of software and equipment. Encourage the use of critical thinking as students experience the use of telecommunication equipment.

Equipment/Supplies

1. Computer with monitor and disk drive
2. Computer printer (if needed)
3. Modem
4. Telecommunication software
5. Connecting cables

Evaluation Key

Instructor evaluation of student performance of this activity should be based on participation in and completion of the activity. Instructors may wish to use a written test or short technical paper to further evaluate student understanding of the processes involved in the activity.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified to meet the needs of special students. It may not be necessary, because this technology is very common among handicapped citizens. If needed, however, pair special-needs students with non-special-needs students in order that they may experience the activity.

MODERN TELECOMMUNICATION

Activity Overview
You will participate in using a personal computer and modem to communicate with students using similar equipment at another location.

Challenge Statement
Modern telecommunication is one of the most important areas of technology today. Developing an understanding of the basic equipment and software is a fundamental element of technology and society.

Objectives
- To work with the tools of telecommunication
- To better understand the wide scope and impact of telecommunication

Vocabulary/Concepts Reinforced
- Communication
- Fax machine (facsimile)
- Modem
- Telecommunication

Equipment/Supplies
- Computer with monitor and disk drive
- Computer printer (if needed)
- Modem
- Telecommunication software
- Connecting cables

Introduction
Modern communication technology includes many elements. One of these, telecommunication, deals specifically with sending and receiving messages over long distances. In the past, we considered the telephone as the principal tool of telecommunication networking. With a little patience and a lot of luck, you could make a telephone call to almost anywhere in the world. As satellite systems were installed in outer space and fiber optic cables stretched around the country, telephone communication evolved into a relatively high-technology system. At about the same time, computers and fax machines were developed for general use by both the private and public sectors.

It is very likely that many businesspeople in the future will be able to conduct most of their business from home offices. Home offices will probably have several pieces of telecommunication equipment, including a personal computer, a modem, and a fax machine. With these basic pieces of hardware, a businessperson can conduct many operations, such as sending and receiving correspondence, orders, and billing information; making airplane and hotel reservations; ordering lunch; and other routine business activities. These basic communication tools have already begun to change the way we conduct business.

Procedure

1. Your instructor will arrange the connection of a computer in your lab area via a modem with a similar set of equipment in another school. He or she will demonstrate the correct procedure for creating and sending basic messages using the computer software available to you.
2. Your task in this activity is to design a computer message which can be sent to the other school via the computer modem connection. Your class may want to establish some specific exchange of information or design a game that can be played between the two schools.
3. Ensure that everyone, whether they are working in groups or individually, has an opportunity to share in the sending or receiving of a message.
4. In a follow-up discussion of the activity, discuss how this type of technology can be used to improve the efficiency of a business or to create some new type of business venture.

Evaluation

Evaluation of your performance in this activity will be based on your participation in and completion of the activity. Additional evaluation may be used as the instructor deems necessary.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 13
(5 DAYS)

BASIC TECHNICAL DRAWING—SKETCHING

Essential Elements: 1, 2, 3
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity is intended to introduce students to basic technical drawing through sketching. The activity will help students understand the importance of technical drawing as a communication medium.

Challenge Statement

Technical drawing is basic to all industrial design and fabrication work. It will also be a basic function of many of the problem-solving activities in which students need to design and construct devices. Every object that is either constructed or fabricated begins its early stages of development as a sketch either on drawing paper or in a computer. Designers often spend hours "thinking with a pencil" as they make simple sketches of their ideas, which will later be converted into mechanical or construction drawings.

Systems Model

Resources
Materials
Tools and equipment
Background information

Processes
Design
Lettering
Layout
Proportion
Measurement

Applications
Illustrating technical ideas and information using basic mechanical drawing

Impact
Communicating technical ideas and information

Interfacing with Other Disciplines

Language Arts:	Students will perform written communication in graphic form.
Mathematics:	Students will add, subtract, multiply, divide, and work with an architect's scale and the principles of volume and area.
Social Studies:	Students will use a universal communication technique.

Critical Thinking Skills Reinforced

Students will apply technical sketching to transfer size descriptions to drawing paper. They will analyze technical information and extend information into a graphic format, then evaluate their results.

Teaching Tips

1. Express the importance of neatness and clarity in making sketches.
2. Explain to your students how technical drawing is used as a system of communication within industry.
3. Establish a bulletin board display of different types of mechanical and construction drawings.
4. If possible, demonstrate a CAD program to your students.
5. Arrange a tour of the drafting lab at your school for your students.
6. Begin the series of sketches with a series of simple straight lines. Have your students draw a set of horizontal lines, vertical lines, and inclined lines at 45 degrees, at 30 degrees, at 75 degrees, and at 15 degrees.
7. Make up a series of three-dimensional figures using scrap lumber. These objects should include both flat and angled surfaces. They should also be cut to sizes and shapes that can be measured and scaled down if needed.
8. Have students make sketches of the three-dimensional objects on graph paper. Show them how to make orthographic projection sketches of the objects.

Instructional Strategy

To open the activity and focus the attention of your students, present and display actual sketches of familiar products and designs. Monitor your students through guided practice drills until you are confident of mastery. Evaluate, then display end products.

Equipment/Supplies

1. Drawing pencils
2. Drawing paper (preferably grid or graph paper)
3. Architect's scales
4. Assorted small objects to draw

Evaluation Key

Instructor evaluation will be based on student participation in and completion of the activity. Students will be asked to explain and display their sketches. The instructor needs to ensure that students are able to visualize the front, right side, top, left side, rear, and bottom views of objects.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity involves several relatively simple sketches to be drawn by looking at an object, calculating basic measurements, and drawing the basic views of the object. Some special population students may have difficulty with the drawings, although many will be able to manage them with little or no trouble. You may find, however, that your special-needs students will enjoy this activity and will perform quite well with it.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 13

BASIC TECHNICAL DRAWING—SKETCHING

Activity Overview

Students will learn to use sketching techniques as an introduction to technical drawing. Students will handle simple three-dimensional objects, measure them, and transfer various views of them to drawing paper.

Challenge Statement

Technical drawing is one of the most important elements of both the manufacturing and construction industries. Although much of the design work done by industry is completed with CAD systems, basic sketching is used to visualize the sizes and shapes of objects. Basic sketching skills are an important part of a designer's ability to share his or her ideas with others.

Vocabulary/Concepts Reinforced

- Design
- CAD/CADD
- Triangles
- Oblique drawing
- Pictorial
- Scale
- Orthographic projection
- Written communication
- Freehand sketch
- T-square
- Isometric drawing
- Measurement

Equipment/Supplies

- Drawing pencils
- Drawing paper (preferably grid or graph paper)
- Architect's scales
- Assorted small objects to draw

Introduction

Technical drawing is an important component of the manufacturing, construction, and communication industries. Nearly every product these industries produce begins as a technical drawing. Technical drawing involves several levels, from simple sketches to multilayered three-dimensional CAD drawings. Each of the major industries relies on technical drawings to perform one primary function—to communicate ideas or technical data. We often think of technical drawings as being limited to mechanical, engineering, or architectural drawings. Although these certainly are examples of technical drawing, there are many others, including maps, charts, layouts, character animations, and others.

In order to begin understanding technical drawing, you must first understand that drawings are made up of a few basic elements. Every drawing is basically a series of points, lines, and their spatial relationships. In most technical drawings we use a series of conventions or symbols to represent different things. Technical drafters also use different types of lines to present different information, such as object lines, invisible lines, extension lines, dimension lines, break lines, and many more. All of these are universally accepted to represent specific information to others.

Technical drawings often begin as simple freehand sketches. An engineer may sketch out an idea that he or she has developed and pass it along to a drafter for more technical finishing. The technical drafter will make a detailed set of drawings and pass them along to the shop supervisor for fabrication. The shop supervisor must be able to read the drawings in order to go about fabricating the part. He or she may even have a better idea, make a sketch of the idea to improve the part, give it to the design engineer to make formal drawings for review, and then give it to a production engineer.

Sketching is an important function at all levels. It is a very important communication process for industry. It is also a useful thinking tool for individuals. Many inventors and designers use sketching to develop ideas for themselves. Often they keep notebooks of their sketches and use them as references. Sketches do not have to be elaborate or detailed to be useful. In fact, you really do not have to be a particularly talented artist to make effective sketches. Some of the most important inventions were first drawn as very simple sketches. Thomas Edison's initial working drawing of the phonograph was a series of rough sketches made on a piece of paper about the size of your notebook paper. Thomas Jefferson's first drawing for the design of the U.S. Capitol was a rough sketch about 3 inches square. Neither of these sketches was very sophisticated, but both helped the designer put down his visual thoughts on paper.

Procedure

In this activity you will learn how to make effective freehand sketches. You will use the basic drawing tools that designers use to make freehand sketches—graph paper, pencils, and an eraser. As you work through the exercises that your teacher will present to you, remember that although these drawings are not intended to be works of art, they are to be drawn as neatly as possible.

Your instructor will guide you through the following series of freehand drawing exercises:

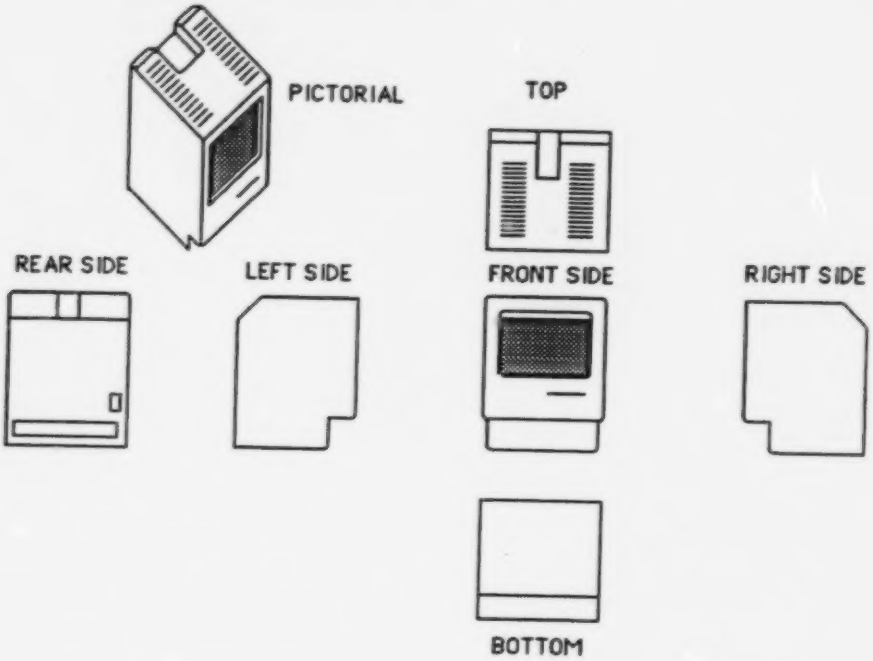
1. Practice drawing basic lines: horizontal, vertical, inclined.
2. Sketch three-dimensional objects using the orthographic projection method to show front, side, top, and bottom views.
3. Use the architect's scale to measure and sketch an object. (Use the scale to draw a large object onto a smaller piece of graph paper.)

Evaluation

You will be evaluated on your participation in and completion of the activity.

ORTHOGRAPHIC PROJECTION

Orthographic projection is used to present three views of an object to understand what the object looks like. An orthographic projection uses the top, front, and side views of an object; the left side, rear, and bottom sides are not shown. The top, front, and side views show enough of the object to indicate the dimensions necessary to make the object.



COMMUNICATING WITHOUT WORDS

Essential Elements: 1–5, 12
TAAS Objectives: Language Arts: RC 1–6; WC 1–7
Mathematics: C 3, 4

Activity Overview

This activity is intended to help students understand the importance of visual communication and how it can be used to send and receive messages without words. Students will work in small groups to plan, shoot, and produce a series of photographs that tell a story or communicate a message.

Challenge Statement

Effective communication is one of the most important technological systems that exists today. Recent developments in satellite communication have brought us to the point of effectively sending a message to anyone anywhere in the world in a matter of a few seconds. Other devices such as the video recorder and camcorder have become revolutionary tools, effectively helping to cause such major world events as the dismantling of the Soviet Union. Developing a sense of effective message communication is important to all students.

Systems Model

Resources
Background information
Materials

Processes
Material handling
Communicating a message without words

Applications
How to develop effective communication without words

Impact
Communication of information can have both positive and negative effects.

Interfacing with Other Disciplines

Language Arts:	Students will create a message through visual communication. They will decipher messages and compare results.
Mathematics:	Students will use math skills to design the layout for a pictorial message.
Science:	If a darkroom is available, students will have the opportunity to work with photographic chemicals.
Social Studies:	Students will discuss photographic images and their impact on society. They will extend this information into written and pictorial messages.

Critical Thinking Skills Reinforced

Students will work in groups to brainstorm, create, design, organize, and produce a pictorial poster to give a visual message. Then each student will analyze the group's poster to deduce the intended message. The students will record the message. They will evaluate their deductions by having the true message revealed, at which time the students will evaluate the validity of the pictorial message.

Teaching Tips

1. This activity can be completed using simple disposable cameras if needed. It is recommended, however, that your students have access to a simple photographic darkroom in which they can process exposed film and make photographic prints.
2. Review with your students the proper handling procedures for all equipment, including cameras, photographic materials, and darkroom equipment.
3. Use this activity as a small-group project.
4. Student rewards can consist of penny candy, extra computer time, or extra points.

Instructional Strategy

Catch student attention by explaining the "rules" of the activity. Develop an atmosphere of secrecy to enhance interest. Preapprove and monitor each group's message and pictures for appropriate content. Organize all materials in advance to maximize time. If the students use the darkroom, check for understanding of the development process, and reteach if necessary. Actively involve all students in the evaluation process.

Equipment/Supplies

1. Cameras
2. Photographic film
3. Photographic printing paper
4. Processing chemistry for both film and prints
5. Darkroom equipment, including enlargers, timers, processing trays, print tongs, etc.
6. Rubber cement for mounting prints
7. Posterboard

Evaluation Key

Instructor evaluation of student performance on this activity should be based on participation in and completion of the activity. Judge student work by how well their photographs communicate the intended message. Judge the quality of workmanship based on their previous instruction or experience.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified to meet the needs of special students. It is advisable to team special-needs students with non-special-needs students. If your special education department has personnel resources available, you may want to have additional help during this activity.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 14

COMMUNICATING WITHOUT WORDS

Activity Overview
You will work in small groups to design, shoot, process, and assemble a series of photographic prints that communicate a message or tell a story without the use of words.

Challenge Statement
Visual communication continues to be one of the most important elements of modern technology. In a world where there are in excess of 3,000 different languages, the use of visual messages is important to universal communication. This idea, coupled with the old adage that "a picture is worth a thousand words," provides us with the basis for an important learning experience.

Objectives
- To describe how visual symbols can be used to communicate messages
- To explain the basic photographic process
- To handle basic photographic materials
- To create a visual communication message without using words

Vocabulary/Concepts Reinforced
- Communication technology
- Visual communication
- Exposure control
- Darkroom processes

Equipment/Supplies
- Cameras
- Photographic film
- Photographic printing paper
- Processing chemistry for both film and prints
- Darkroom equipment, including enlargers, timers, processing trays, print tongs, etc.
- Rubber cement for mounting prints
- Posterboard

Introduction
Visual communication is one of the most important elements of modern technology. Visual communication has its roots in the cave drawings and other illustrations created by prehistoric people, and it has evolved into one of the most widely used systems of universal communication. Although there are some 3,000 different spoken languages around the world, visual images have a common thread of understanding that crosses most language barriers. A picture of a dog scratching at fleas, for instance, is more easily understood than trying to communicate that message with words.

Our lives are continuously being affected by visual messages. They exist in the form of road signs, company logos, advertisement designs, message logos, and various types of photographs. The photographic image is perhaps one of the most powerful forms of message communication. The old adage "a picture is worth a thousand words" really explains the importance of the photographic image. Newspapers, magazines, and books rely on photographic images to supplement the written text for the information that they intend to communicate. Very often, the accompanying photographs communicate the message more effectively than does the actual printed text.

Procedure

1. Your instructor will discuss the use of photographic images to communicate messages. He or she will present the class with examples illustrating how photographs can become very powerful communicators.
2. The instructor will demonstrate the proper use of handling the camera and darkroom equipment. This demonstration may also include technical information about processing photographic film and paper. It is important that each student know and understand the correct method for handling photographic materials and chemistry.
3. The class will be divided into small groups. Each group will use a camera, film, and photographic print paper to create and communicate a message to the entire class. Each group will use a series of at least six pictures to tell a story or communicate an intended message.
4. Before beginning the picture-taking session, your instructor will need to approve your intended "message."
5. Upon completion of the picture-taking and print-making session, each team will arrange its photographs on a posterboard and then present them to the entire class without verbally explaining the message. Each student will write what he or she thinks the message is and turn the paper in to the teacher. After each group has shared its poster visually, the instructor will share some of the class members' guesses for each visual message. Then the group will disclose the real message. The student or students that get the message right will receive a reward of the teacher's choice. The group that presents its message most clearly, by having the most students guess correctly, will also receive a reward.

Evaluation

You will be evaluated according to your participation in the group activity, as well as how well you complete the assignment.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 15
(1–2 WEEKS)

THE MIGHTY COMMUNICATION CHALLENGE

Essential Elements:	5, 12
TAAS Objectives:	Language Arts: RC 5 Mathematics: C 1

Activity Overview

Teams of two students will develop their own code and method of communicating messages back and forth over a given distance without facing each other or using any vocal communication. The system must include a method of feedback and overcome noise obstacles.

Challenge Statement

All forms of communication are based on the concepts emphasized in this activity. These concepts can then be incorporated into all fields where efficient communication is a focus.

Systems Model

Resources
Time
People
Money
Information
Energy source

Processes
Designing a system
Encoding and decoding
Building a functioning system

Application
Communication
Standardized code
Transmission and reception
Feedback system

Impact
Faster, more effective communication methods

Interfacing with Other Disciplines

Language Arts:	Research the concepts related to conveying feeling, meaning, and tone of communication.
Mathematics:	Numerical sequences may be used to create a communication method.
Social Studies:	Research the impacts of communication on society throughout history.

Computer Science: Investigate the process of turning English into computer languages and then into machine code and magnetic and optical storage.

Critical Thinking Skills Reinforced

Students will use knowledge and concepts covered in the classroom to solve a problem. They will evaluate past and current methods of communicating to find the best base for a solution to a new problem. After testing their solution, they will have the opportunity to assess results and modify and revise their solution.

Teaching Tips

1. Show the students the testing site and the conditions under which the competition will be held so that they may effectively plan against "noise."
2. Emphasize the importance of a feedback system and testing and improving each system.
3. Use the transparency to introduce the topic and give background information.

Instructional Strategy

Open the class with the creative challenge of designing a nonverbal language to get your students' attention for the activity. Organize materials in advance to save time. Monitor each group. Guide toward, but do not suggest, options. The students' projects are self-evaluating.

Equipment/Supplies

1. A room that will allow each team to sit 20 or more feet apart
2. Graphic art materials (posterboard, markers, etc.)
3. Anything nonelectrical in the lab

Evaluation Key

The team that accurately conveys "teacher-generated" messages back and forth in the least amount of time receives the highest grade (100%). A passing grade (70%) is to be the lowest grade given to any team who brings a plausible and completed "system" to the competition. Standard written testing of the information covered in the classroom before the competition will be a good evaluation method as well as an identifier to check the level of student comprehension before they begin their designs.

Support Materials

1. Background Information Outline
2. Transparency 15–1
3. Video clips from the BBC series "Connections" explaining communication history and technologies (telegraphs through satellites)
4. Resource books on communication and technology from Delmar, McGraw-Hill, etc.
5. Information gained from your English and computer science departments

Modifications for Handicapped, Disadvantaged, and LEP Students

LEP Students: This competition can be performed in any language, at any level or proficiency. Gifted and Talented: The complexity of this activity can be increased by altering the testing site (e.g., send the message around a corner or across a greater distance, or hold the competition in a dimly lit environment with several radios playing, etc.).

BACKGROUND INFORMATION OUTLINE

"The Mighty Communication Challenge"

- *What is communication and what is its function?*
    - —Conveying information, meaning, tone, influence, emotion, images, attitude, and ideas
    - —Encoding, transmitting through a medium, receiving, decoding
    - —What are "noise," "context," and "feedback"?

- *History:*
    - —Societies are built in part on their ability to communicate effectively
    - —Communication systems throughout history, their level of efficiency, and societal effects

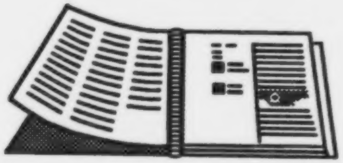
- *Codes and standardization of meaning:*
    - —How can two people read the same article and interpret it differently?
    - —Why are numbers universal?
    - —Which systems have the most effective "feedback" and "quality control" methods?
    - —Which systems block out the most kinds of noise the best?

- *Impacts:*
    - —Faster and more accurate methods of communicating create …
        - —a "smaller" world
        - —a loss of individual cultures
        - —an increase of change in our world
        - —a higher general level of education

What other impacts do you see?

Introduction of Concepts ⇨ **Problem Solving** incorporating and emphasizing the concepts ⇨ **Competition** evaluating the solutions

TRANSPARENCY 15-1



"The Mighty Communication Challenge"

Resources

- Tools and Materials
- Time
- People
- Money
- Energy Source(s)

Processes

- designing a system
- encoding and decoding
- building a functional system

Impact

- *Faster & more effective communication methods create. . .*

- a "smaller" world.
- a loss of individual cultures.
- an increase of change in our world.
- a higher general level of education.

What other impacts do you see?

Application

- **Communication** of any kind (people, machines, animals,etc.) requires a *standardized code*, a method of *transmission and reception,* and a *feedback system.*

THE MIGHTY COMMUNICATION CHALLENGE

Activity Overview

How would you communicate a message to your friends at the other end of the room if you couldn't see them, speak to them, walk over to them, or use any known code or language?

Challenge Statement

For any kind of communication to occur, a standardized code, method of transmission, and feedback system must first be developed. How would you create a nonverbal communication system?

Objectives

- To use the knowledge and concepts introduced in the classroom portion of this activity to evaluate past and present methods of communicating
- To solve a problem in a new way

Vocabulary/Concepts Reinforced

- Transmitter
- Feedback
- Decoding
- Channel
- Noise
- Medium of communication
- Receiver
- Encoding
- Standardization of codes and meaning

Equipment/Supplies

You may use any available equipment or supplies to create your system. However, your system may not include any electrical devices.

Procedure

Using any available equipment and materials, develop a fast and efficient system of communicating accurately over a distance of 15 feet without breaking any of the following rules:

- Partners must position themselves at opposite ends of the given distance, facing away from each other.
- You may not verbalize any sound or turn to look at your partner during the competition.
- All competitors must be seated during the competition.
- Once the competition begins, neither partner may move from his or her seated position.
- No electronic devices or means of communication are allowed.
- No physical connections between chairs at the start of the competition (e.g., strings, poles, etc.) are permitted.
- Messages must be transmitted exactly.
- Receiver will become transmitter (and vice versa) at some point, and messages will vary and be comprised of only:
  - the English alphabet, upper- and lowercase letters;

- any positive number (and zero itself); and
- a "space," quotation marks, a question mark, an exclamation mark, a period, and a comma.

Hints

- Make your system FAST and UNCOMPLICATED.
- Design your system to deal with "noise"; remember, you will be competing at the same time as the rest of the class.
- Make a fast and effective feedback system.
- Learn your code on both ends and keep a copy nearby during the competition.
- Devise a backup communication system in case something goes wrong.
- Include codes for "Repeat," "Slow Down," "End," "Wait," etc.
- TEST YOUR SYSTEM AS MANY TIMES AS POSSIBLE!

Evaluation

You and your partner will be competing for a grade. The team that accurately conveys "teacher-generated" messages back and forth in the least amount of time receives the highest grade (100%). A passing grade (70%) will be the lowest grade given to any team who brings a plausible and completed system to the competition. You will be tested on the background information of this activity (covered in class) before the competition. (It's a good method of information evaluation, as well as teacher verification of your concept comprehension before you begin your system design.)

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 16
(2 WEEKS)

"CAN YOU SELL A CAUSE?"

Essential Elements: 1, 4, ~~5, 6~~, 14
TAAS Objectives: Language Arts: RC 1–6, WC 6–7
Mathematics: C 2, 3

Activity Overview

The student, while working in a team, will explore, design, and create a modern ad campaign presenting a single view of a controversial issue related to the use of technology.

Challenge Statement

TV, radio, and graphic advertisements all have an impact on our lives. Just look what they do for selling tennis shoes. These means of communication can also be used to strengthen or change public feelings about issues caused by the quest for new and exciting technologies. Your students will use a multimedia ad campaign to convince the world of their view of one of these issues.

At the completion of this activity, students will understand how social impacts of technology can be manipulated by the different forms of media to persuade people to support their cause. They will also have the chance to use media development equipment.

Systems Model

Resources
Students
Teacher
Parents
Resource materials
Video equipment

Processes
Brainstorming
Designing
Researching
Compiling
Presenting

Applications
Political influence
Economic gain
Personal communication
Consumerism

Impact
Political

Social
Economic

Interfacing with Other Disciplines

Language Arts:	Apply fundamental principles of English usage to help convey meaning and tone to media scripts and print ads.
Mathematics:	Math skills will be used in editing film and designing graphics for presentations.
Social Studies:	Investigate the major impact advertising has had on political and social development in the U.S. and the world.
Art:	The teacher can explain how layout and color can be used to enhance or detract from graphic art.

Critical Thinking Skills Reinforced

The students will determine and apply persuasive logic to explain a line of reasoning. They will analyze information to help determine the potential outcome of a decision and formulate an informed position based on data learned while researching a problem. Students will weigh and assess the impact advertising has on everyday life.

Teaching Tips

1. This activity is usually run by the students. Try not to limit the students' creativity by suggesting media equipment or subject format.
2. The primary responsibility of the instructor is that of resource or material provider.
3. Biweekly reports, produced by the teams and outlining their progress rate, help keep both the students and teacher on track.

Instructional Strategy

Open the activity with a lecture to explain objectives and procedure for this activity. Use group discussion to give examples of technological issues that could cause controversy. Show successful examples of the three major types of ads available. Use the activity as a small-group project. Have students present completed ad campaigns to the class as a means of evaluation.

Equipment/Supplies

1. Video camera, tripod, camera lights, camera microphone, backdrop material
2. Animation and graphics program, computer, film-editing unit
3. TV, VCR
4. Audiocassette recorder, microphone, headphones, stopwatch
5. Layout tools, graphic arts material

Evaluation Key

The student teams will be graded by the following criteria:

- Student participation
- Quality of media production
- Presentation evaluation forms from the teacher and classmates

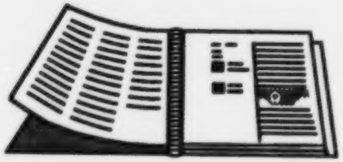
Support Materials

- Operation manuals for video and audio recording equipment.
- Evaluation sheet for presentation
- Transparency 16-1

Modifications For Handicapped, Disadvantaged, and LEP Students

- Have students who are English deficient work on an ad campaign using their native language.
- Physically handicapped students should be able to assist in production but at a reduced pace.
- Gifted and talented students can be encouraged to use advanced visual and graphic art techniques to produce their ad.

TRANSPARENCY 16-1



"Can You Sell a Cause?"

Resources

- Tools & materials:
- Time:
- People:
- Money:
- Energy source(s):

Processes

- Brainstorming & designing
- Researching & compiling
- Creating presentation materials

Impact

- Political, social, and economic change

Application

- Political influence
- Economic gain
- All occupations require people who can communicate their ideas effectively

"CAN YOU SELL A CAUSE?"

Activity Overview

What do you believe in and how would you get the rest of the world to see it your way? Working in a small group, you and your fellow classmates are going to create a modern ad campaign showing one view of a controversial issue that has been caused by our use of technology.

Challenge Statement

TV, radio, and graphic advertisements all have an impact on our lives. Just look what they do for selling tennis shoes. These means of communication can also be used to strengthen or change public feelings about issues brought about by the quest for new and exciting technologies. You will use a multimedia ad campaign to convince the world of your views of one of these issues.

Objectives

- To investigate how the media influences our lives
- To research and use the media equipment in your school
- To present your views to a group of people

Concepts Vocabulary/Reinforced

- Basic communication
- Telecommunications
- Computer application
- Media
- Transmitter
- Target population
- Receiver
- Slogan
- Electronic media
- Graphic arts
- Problem solving
- Channel
- Medium
- Logo
- Propaganda

Equipment/Supplies

You may use all available audio/visual and graphics equipment (examples: video camera, copying machine, cassette recorder, overhead projector, video editing machine, computer graphics program, etc.).

Procedure

The following guidelines will give you an idea of how to proceed with this project; you may change them to fit your production and presentation needs.

1. Remember to use this format for organizing your ads and presentations:
   a. State your views.
   b. Give evidence for your views.
   c. Restate your views.
2. Form a group of three to five students.
3. Decide which "positions" members of the group will hold and be responsible for. (Examples of positions that can be selected are team leader, production engineer, studio manager, writer/producer.)

4. Brainstorm an issue that all members of the group feel they can work with comfortably. Write out your position and give a copy to your teacher.
5. Determine the target population and which ad would be best suited for those people. Also decide which media is best suited for these people.
6. Make a list of equipment and materials you will need to make your ad and presentation and give this to the teacher.
7. Lay out the scripts and graphic ads.
8. Assemble the necessary people and equipment to make the ads. It may take more than one try to make a successful ad, so plan your time wisely.
9. Twice a week, the team leader must report to the teacher and outline the progress of the group and a future time line. This will help your team to schedule equipment and supplies in a timely manner.
10. When the group has completed its entire campaign, prepare your presentation.
11. Present your ad campaign to the class. Dress for success.

Hints and Suggestions

- All members must work together for a successful presentation. There can be more than one person for each job.
- Don't spend all your time arguing about which issue is "best." You must have a complete ad campaign to get credit for this project.
- As an advertising firm, presenting your ideas to a company or interest group is as important as your final ad to the public. Polish your act by going through the presentation at least once. If you have a video camera available, film and review your group as it would look during the presentation.

Evaluation

You will receive three grades from this project.

- The team will receive a grade based on how well the ad is produced. Neatness and accuracy are important.
- During the presentation your teacher and fellow students will complete an evaluation sheet that will determine your second grade.
- The teacher will determine your group participation grade.

Presentation Evaluation Sheet

"Can You Sell a Cause?"

Team Name ________________________

Class Period _____

After watching the advertising presentation, what image has this group created in your mind about its chosen cause?

What could you suggest to this group that would make its presentation more professional?

What part of the presentation did you like best? Why?

What part of the presentation did you like least? Why?

Based on your own comments, what grade would you give this presentation? ____________

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 17
(2 WEEKS)

DESKTOP PUBLISHING

Essential Elements: 1, 4, 6
TAAS Objectives: Language Arts: RC 1–6; WC 1–7
Mathematics: C 3–4

Activity Overview

Students will produce a newsletter using a microcomputer and word-processing and graphics software.

Challenge Statement

Students enrolled in basic industrial technology courses should be able to use basic computer programs and equipment to design and produce graphic material.

Systems Model

Resources
Background information
Computer hardware
Computer software
Copy machine
News information

Processes
Newsletter design
Written composition
Word processing
Utilizing computer graphics
Making the master
Making copies from a master

Applications
Organization
Desktop publishing
Documentation

Impact
Computer skills

Interfacing with Other Disciplines

Language Arts: This activity supports language arts concepts in the design and production of a desktop-published document.
Mathematics: Mathematics skills are used in layout for publishing.

Social Studies: Students will understand a basic, technical communication process that strongly impacts society.

Critical Thinking Skills Reinforced

Students use elements of application in preparing written material for the project. They analyze the computer program and written materials to be used in the published document. They synthesize the information to design and develop the document and also to organize, plan, and produce the written material. An evaluation is used to assess students' understanding of the concepts and procedures introduced in this activity.

Teaching Tips

1. Allow the students to be creative. Be involved enough to not let the topics become too controversial. Also make sure that all articles are in good taste and not likely to affront anyone.
2. You might work with an English or language arts teacher on this assignment. You also might work with the school newspaper faculty adviser to publish the school newspaper.
3. This module could be approached as a community service activity. A newsletter for parents or a service organization might be worthwhile. You might consider inviting your local newspaper editor to give a talk about publishing.

Instructional Strategy

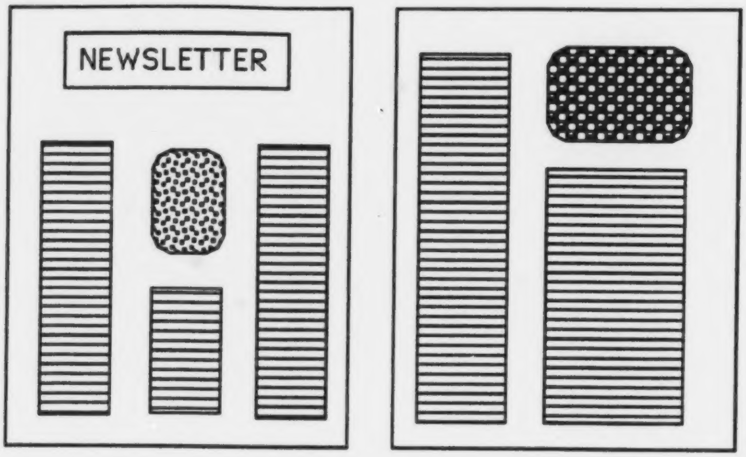
Introduce the activity and demonstrate word-processing and painting or drawing software programs. Communicate your expectations for the newsletters to your students by identifying the theme of the newsletter and articles. Assign articles to student reporters. Organize the proper tools and equipment for student use. Monitor all students for participation. Stress important concepts and techniques. Close instruction with the class presentations and evaluations.

Equipment/Supplies

1. Computer
2. Word-processing software
3. Painting or drawing software
4. Photocopier or offset press
5. Paper

Evaluation Key

1. Define:
   Word processing: A word-processing program is one that is a writing tool; it allows you to create different types of documents, correct errors in those documents, store the documents on a disk, and produce printed copies of those documents.
   Xerography: Xerography uses a special photoconductive plate to transfer images.
   Computer literacy: Once a person has developed the level of skill to transfer the concepts of computer use from one brand to another, or to use several types of computer programs, he or she would be considered computer literate.
   Pasteup: The pasteup is the final, camera-ready copy of the newsletter.
   Layout: A layout is the completed design of actual size.
   Computer graphics: Computer graphics programs allow the user to manipulate the computer to produce graphic images.
2. Use your design and layout skills to arrange the following parts of a two-page newsletter:



Support Materials

Computers in Your Life. 13 min. film. Available from Modern Talking Picture Service, 5000 Park Street North, St. Petersburg, FL 33709-9989. Free.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be used to help students develop good self-concepts and a basic level of occupational awareness. Make the handicapped student feel that he or she belongs. Be sure to call the student by name as soon as possible. If needed, engage a "helping teacher" to assist during segments of this lesson.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 17

DESKTOP PUBLISHING

Activity Overview
Students will use the computer to produce a newsletter.

Challenge Statement
Desktop publishing has changed communication technology drastically in only a few short years. Within a few days, you will have the opportunity to learn how magazines and newspapers are written, edited, and published.

Objectives
- To correctly use the word processor on the computer
- To correctly use the "paint" or draw program on the computer
- To research and write an article for a newsletter
- To paste up a layout for reproduction
- To reproduce the newsletter and distribute copies

Vocabulary/Concepts Reinforced
- Oral and written communication
- Word processing
- Xerography
- Computer literacy
- Pasteup
- Layout
- Computer graphics

Equipment/Supplies
- Computer
- Word processing software
- Painting or drawing software
- Photocopier or offset press
- Paper

Introduction
Desktop publishing is a new term reflecting the ability to put information for publication together in a small space; hence, "desktop." The tool that facilitates this amazing process is the computer. The copy to be printed, as well as the pictures or graphics that accompany the articles, can be done on a computer.

A computer is an electronic information processor. The computer follows instructions given to it by humans via the keyboard or a computer program. Once a person has developed the level of skill to transfer concepts of computer use from one brand to another, or use several types of computer programs, that person would be considered computer literate.

This lesson will use two types of computer programs: a word-processing program and a graphics program. A word-processing program is one that is a writing tool; it allows you to create different types of documents, correct errors in those documents, store the documents on a disk, and produce printed copies of those documents. Depending on the complexity of the word-processing program, many other functions can be carried out, such as correcting spelling errors, moving portions of text from one place to another, and merging information from several documents to create a new document. Computer graphics programs allow the user to manipulate the computer to produce graphic images. These images can be in the form of diagrams, maps, illustrations, or drafting assignments. Usually, some type of external attachment such as a graphics tablet, joy stick, or mouse is used to create the graphic.

To complete this activity, you first must determine the focus of the newsletter. It could be one of the following:

- Newsletter for a local nursing home
- Newsletter for an open house for your school's industrial technology program or a regional industrial technology fair
- Newsletter for the school, focusing on a theme (e.g., technology and school work, food and arts guide to the local hangouts) (Be sure to not compete with the school newspaper. If there is not a current school newspaper, start one with this exercise.)
- Newsletter addressing a current issue confronting the students and/or the community

Each class will choose an editor and assistant editor. Once the topic is decided upon, the editor will work with those students who will be writing articles. Other students will design artwork or take pictures to go in the newsletter.

Two students should work on the layout design of the newsletter. Factors to consider include these: What size sheets of paper to use? Should the newsletter be folded? Should we print on one side of the page or two? Where should pictures and cartoons go? How many columns across the page should there be?

As the articles are completed, they should be typeset on the word processor by the author(s). After a copy is printed, it should be proofed and corrections made. After a final copy is printed, it should be pasted into place for the newsletter. A layout is the completed design of actual size. This provides a guideline for the final design and a time to look for any areas that need to be altered. The pasteup is the final, camera-ready copy of the newsletter. Using the layout as a guide, all final copies of articles, artwork, and masthead are put in place.

Production time has arrived. Xerography is a popular form of reproduction of originals. It is similar to photography, but does not require sensitized paper or plates. Xerography uses a special photoconductive plate to transfer images. Copies of the newsletter that have been printed need to be collated and stapled. Each student should receive several copies to distribute to the targeted audience.

Procedure

1. Observe and take notes on the demonstration of word processing.
2. Hand-draw pictures if your computer does not have a graphics program.
3. Choose an editor and assistant editor. Take assignments and conduct research.
4. Complete articles; use the word processor on articles; work with the editor to make corrections.
5. Paste up articles into final copy.
6. Reproduce copies of newsletter.
7. Assemble newsletter and distribute.

Evaluation

You will be evaluated on your completion of the Worksheet and the activity.

WORKSHEET

1. Define:

   Word processing: ____

   ____

   Xerography: ____

   ____

   Computer literacy: ____

   ____

   Pasteup: ____

   ____

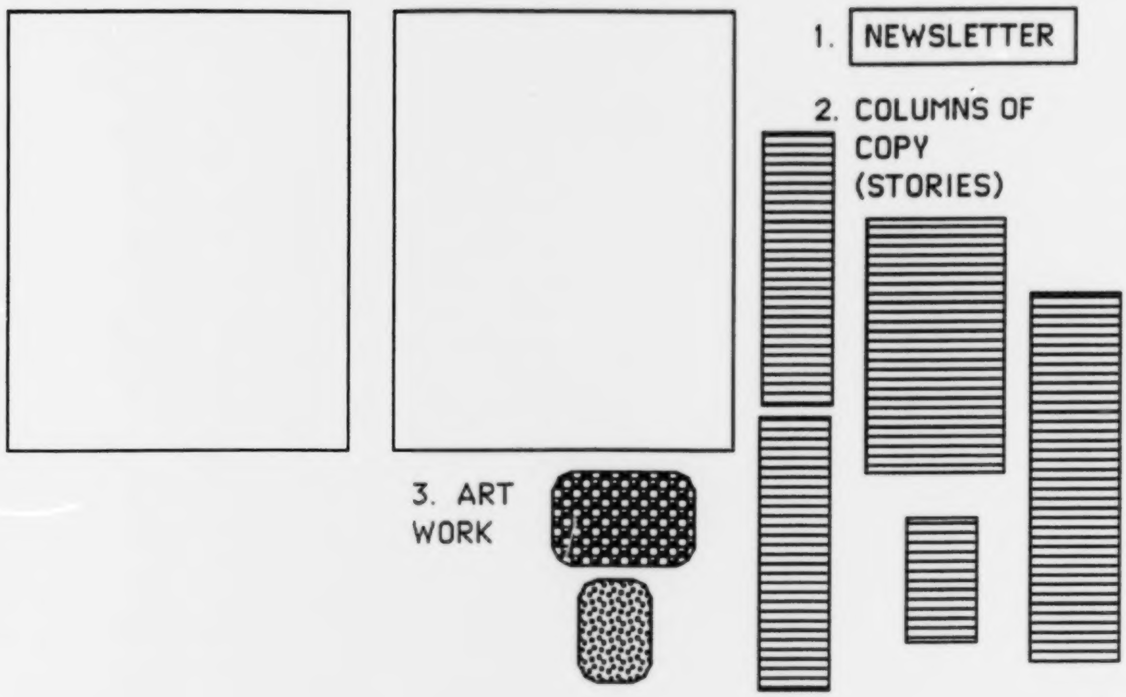
   Layout: ____

   ____

   Computer graphics: ____

   ____

2. Use your design and layout skills to arrange the following parts of a two-page newsletter. Remember the elements of design when considering where each piece of copy and artwork should be placed. Sketch on the blank newsletter pages, or draw arrows from the three parts (masthead, copy, and artwork) to indicate where they should be placed.


1. NEWSLETTER
2. COLUMNS OF COPY (STORIES)
3. ART WORK

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 18
(2–3 DAYS)

SYNCHRONOUS COMMUNICATIONS SATELLITE (SYNCOM)

Essential Elements: 5, 19
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4

Activity Overview

Students will investigate the use of space-based communication systems by studying about and building a model of SYNCOM, one of the first communications satellites launched by the United States.

Challenge Statement

Students should develop a basic understanding of all types of communication systems. This activity provides an opportunity to explore one of these systems as well as the modeling process.

Systems Model

Resources
Materials
Tools and equipment
Background information

Processes
Material handling
Cutting
Bonding
Shaping
Finishing

Applications
Space-based communication system
Technology

Impact
Basic communication systems
Modeling

Interfacing with Other Disciplines

Language Arts:	Students will follow sequential directions to construct a model. They will give a verbal description of their satellite.
Mathematics:	Students will add, subtract, divide, multiply, and work with measurement throughout this activity.
Science:	Students will work with concepts of space-based communication systems.

Social Studies: Students will become aware of impacts and implications of space-based communication systems.

Critical Thinking Skills Reinforced

Through the design and modeling process, students will transform a communication satellite into a model. From the models, students will demonstrate the function of each satellite part, enabling them to evaluate the effectiveness of the equipment.

Teaching Tips

1. You might want to have the students write a paper on communications satellites in general or on one specific satellite.
2. You might also stress the importance of communications satellites in today's society. For instance, all cable TV comes from satellite transmissions, along with most of the national and world news. Some local news and programming may also come to us via satellites linked with a local station's transmission system.
3. Some communication history may be covered at this time, highlighting developments in communication from hand-carried messages to instantaneous broadcasts.

Instructional Strategy

Introduce the lesson by carefully identifying each part of the satellite and its function. Check for understanding and reteach if necessary. Monitor student participation and activity level throughout the activity. Encourage all student involvement. Close the activity with a review of parts and a discussion of the impact of satellites on society.

Equipment/Supplies

1. Yellow or light-colored heavyweight construction paper
2. Black or dark-colored heavyweight construction paper
3. Black pen and/or crayons
4. Ruler
5. Pencil
6. Scissors
7. Compass
8. Paper glue
9. Straight pins
10. Pipe cleaners
11. Lollipop stick
12. SYNCOM Model Parts & Assembly Instructions

Evaluation Key

The student's grade may be determined by the following criteria:

- a. Accuracy
- b. Neatness
- c. Definition of terms
- d. Following directions

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Teaming special-needs students with non-special-needs students is one method of ensuring that they can participate in the activity.

SYNCHRONOUS COMMUNICATIONS SATELLITE (SYNCOM)

Activity Overview

Students will investigate the use of space-based communication systems by studying about and building a model of SYNCOM, one of the first communications satellites launched by the United States.

Challenge Statement

Developing a basic understanding of space-based systems is an important component of understanding modern technology.

Objectives

- To understand more about space-based communications
- To realize the impact satellites have on society
- To understand how satellites have changed communication

Vocabulary/Concepts Reinforced

- Synchronous
- Communication
- Satellite
- Orbit
- Global
- Apogee
- Perigee
- Solar cell

Equipment/Supplies

- Yellow or light-colored heavyweight construction paper
- Black or dark-colored heavyweight construction paper
- Black pen and/or crayons
- Ruler
- Pencil
- Scissors
- Compass
- Paper glue
- Straight pins
- Pipe cleaners
- Lollipop sticks
- SYNCOM Model Parts & Assembly Instructions

Introduction

SYNCOM is a satellite that gets its name from the first three letters of the words *syn*chronous *com*munications. This satellite travels at an altitude of 22,300 miles and in a nearly circular orbit around the earth, completing one revolution every 24 hours. Since that is the same time needed by the earth to make a complete turn on its axis, the orbital speed of the satellite is thus said to be *synchronized* with that of the earth, hence its name.

You are about to build a model of the SYNCOM II satellite, which is the second of the SYNCOM satellites. The first SYNCOM had an electronic failure and was never used for test purposes. However, it was the forerunner for numerous other successful SYNCOM satellites, including the model you are about to construct.

The SYNCOM satellite was the early space scientists' working tool. The scientists could find out how best to send a satellite into a synchronous orbit and keep it there, and how its communications equipment would perform in space. The scientists were curious to know how the equipment would stand up in the day-to-day operation of a global satellite communications network.

The SYNCOM II satellite was a drum-shaped spacecraft 28 inches in diameter and 25 inches high. It weighed 150 pounds, with its instrument cargo adding another 40 pounds. When the sun's radiant energy was converted into electrical power by the 3,840 solar cells that covered the cylindrical outside of the satellite, the output of the transmitting equipment was 25 watts. Two rechargeable nickel-cadmium batteries stored the power created by the solar cells. These batteries functioned when the earth shadowed SYNCOM from the sun on its orbital journey.

At one end of the spacecraft was a small rocket motor, which went into operation as the satellite was boosted into its final orbital path. The space route traveled by SYNCOM took it 19,987 miles from earth at its farthest point, or apogee, and 18,703 miles at its nearest point, or perigee. Also at the rocket-motor end of the communications satellite were four rod antennas that helped ground stations track SYNCOM in space. A polelike antenna extending from the other end of SYNCOM received command signals from earthbound stations. The spacecraft could handle one two-way telephone call, its equivalent in teleprint, or photographic reproduction.

The synchronous satellites now being used in the global network very much resemble SYNCOM II in outward appearance, but they can handle even more communications services.

Procedure

1. *Body*
    a. Trace the design of the SYNCOM body onto the construction paper.
    b. Draw straight lines on the paper to simulate solar cells.
    c. Cut the SYNCOM body out with scissors.
    d. Curl the body by pulling the paper over the edge of a table or by using a straightedge.
    e. Carefully glue the ends together.
2. *Circular ends*
    a. Draw circular ends of the model onto the paper by using a compass and the radius given in the diagram.
    b. Cut out ends.

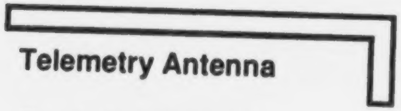
3. *Rocket motor*
   a. Draw rocket motor using a compass, by making arcs as in diagram.
   b. Glue motor together.
4. *Antenna base*
   a. Draw the two parts that will make up the antenna base.
   b. Cut out the two pieces.
   c. Glue the two pieces by folding the pointed tabs inward to make a kind of bottom.
5. *Communications antenna*
   a. Use the lollipop handle to make the antenna.
   b. Cut out a small square of paper, and push a straight pin through the center.
   c. Put some glue on the bottom of the handle before pressing it against the square.
   d. Trim the square to proper size if necessary.
6. *Telemetry antennas*
   a. Use the pipe cleaners to make the telemetry antennas.
   b. Cut and bend the cleaners.
   c. Set aside until final assembly.
7. *Assembling the SYNCOM model*
   a. Glue the circular top and bottom pieces to the SYNCOM body shell.
   b. Put glue on the inner tabs of the body shell and glue snugly.
   c. Attach the rocket motor.
   d. Glue the four telemetry antennas around the rocket motor.
   e. Glue the communications antenna base.
   f. This should complete your model; it is ready for display.
8. Be prepared to identify each of the satellite parts and explain its use.
9. Discuss the uses of satellites and their impact on communications and the military. Can you think of other areas that have been impacted by satellites?

Evaluation

Your model should be neat in appearance, with no stray glue or pencil marks. Your antenna should be straight and properly aligned. Your measurements should be precise. You should have a vocabulary list with proper definitions and be prepared to identify each part and explain its function.

Syncom Model Parts & Assembly Instructions

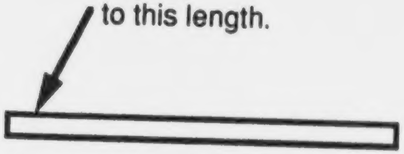
Square for communications antenna base.



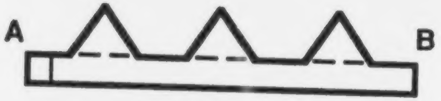
Telemetry Antenna

Bend pipe cleaner to this length and shape.

Cut lollipop handle to this length.

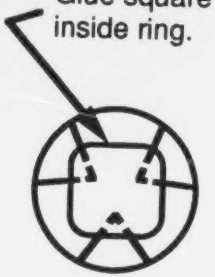


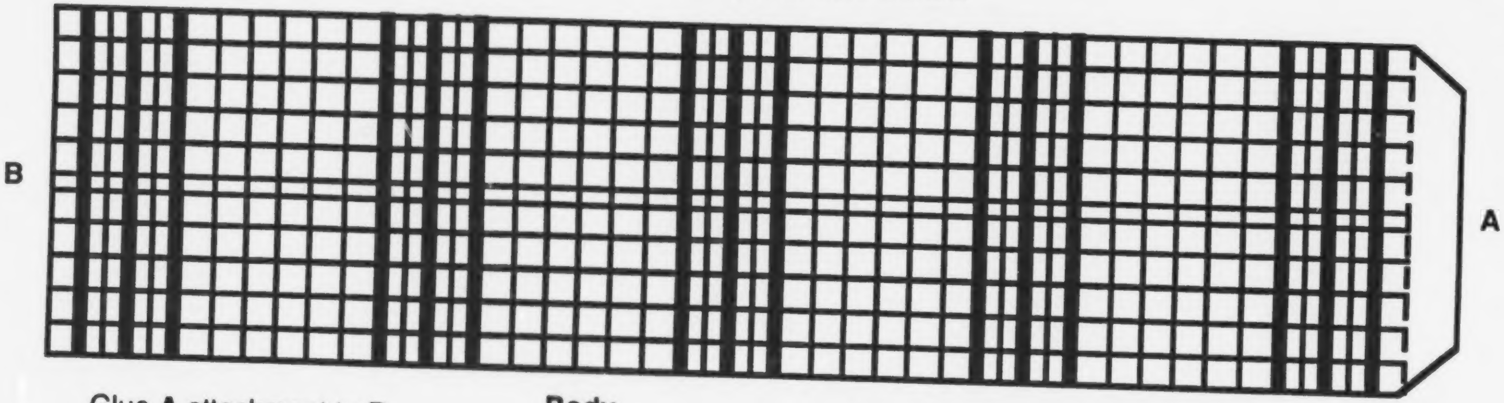
Communications Antenna



Communications Antenna Base
Glue **A** to **B** to form ring as at right, with points bent inward.

Glue square inside ring.





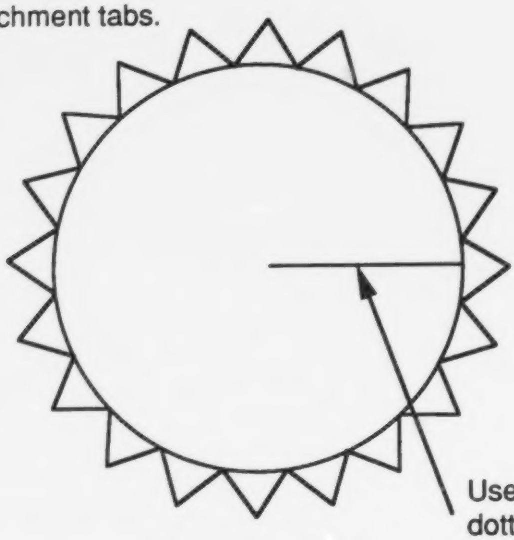
Glue **A** attachment to **B** as far as dotted line.

Body

Draw design on body before bending and gluing.

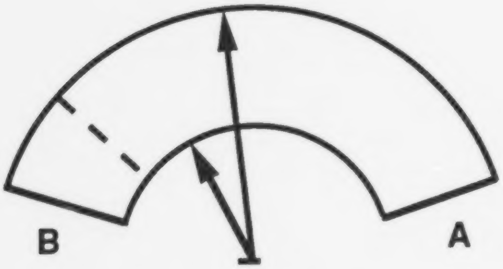
Syncom Model Parts & Assembly Instructions (continued)

Points are attachment tabs.

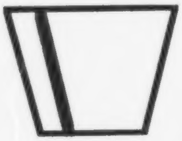


Use this radius to make dotted circle directly on construction paper.

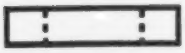
Circular End



Rocket Motor

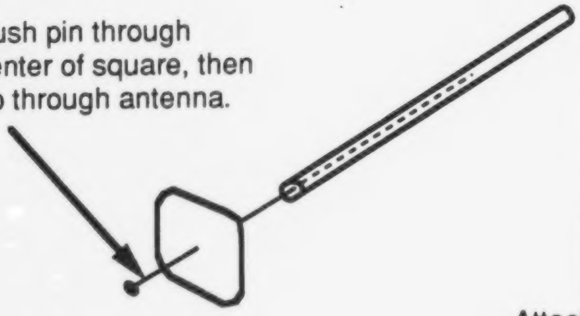


Glue **A** to **B** as far as dotted line. Motor will look like figure above.



Motor Attachment Tab
Bend ends at dotted lines to form U.

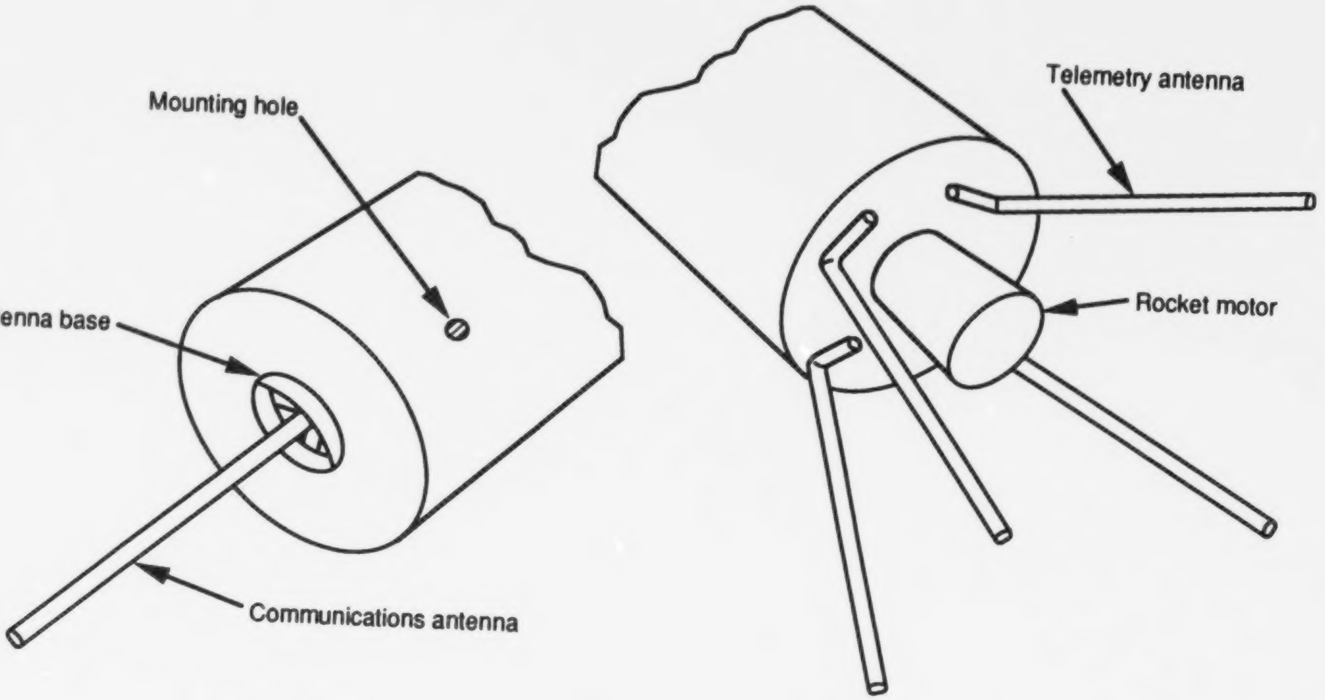
Push pin through center of square, then up through antenna.



Attachment square for communications antenna

Syncom Model Parts & Assembly Instructions

(continued)



Final Assembly

PRINT SHOP

Essential Elements: 4, 6
TAAS Objectives: Language Arts: RC 1–6; WC 1–7
Mathematics: C 1

Activity Summary

Students will learn the importance of the personal computer for communicating ideas and ways of using it to design and produce various graphic arts materials. The materials produced in this assignment may be used to promote your program.

Challenge Statement

Desktop publishing through the use of personal computers is one of the greatest technological accomplishments in recent years. Students enrolled in technology courses should be given an opportunity to explore these areas.

Systems Model

Resources
Materials
Computer hardware
Computer software
Background information

Processes
Design loop
Material handling
Design problem using a personal computer

Applications
Personal computers and graphic software
Technology education

Impact
Personal computer use

Interfacing with Other Disciplines

Language Arts:	This activity supports language arts concepts in the design and production of a desktop publishing document.
Mathematics:	Mathematics skills are used in layout for publishing.
Social Studies:	Students understand a basic, technical communication process that strongly impacts society.

This activity can be used to produce materials for any of the academic areas. Students should be encouraged to develop materials for teachers in other areas. This is a good way to increase awareness of your program as well as involve students in interdisciplinary activities.

Critical Thinking Skills Reinforced

Students apply their understanding of various courses to prepare a graphic layout for a card, sign, letterhead, or banner. They will analyze and extend the background information into a design idea and compose a finished design. Students will judge the completed product.

Teaching Tips

1. Instruction on the use and care of the computer should be completed before attempting this assignment.
2. You may wish to complete at least one greeting card, sign, letterhead, and banner before this activity in order to have examples of what each looks like. Each student may be asked to create a sign or poster using paper, pencils, and crayons prior to this activity in order to emphasize the importance of the personal computer in the graphic arts industry.
3. Due to the size of most computer screens, it will be difficult to give a classroom demonstration unless you have a large (25") monitor. Therefore, simply explain the use of the Print Shop Plan Sheet to get students started. This sheet is very handy as a timesaver when using the Print Shop software in a classroom with a small number of computers. You may also want to have the "Graphics Sheets" (sheets of available graphics, borders, and fonts) either laminated or placed in sheet protectors and bound in a folder for the students to use. This will help the sheets last longer and keep them organized. You may need more than one copy of the "Graphic Sheets" that so several students can plan their work at one time.
4. By using the plan sheets, each student should not need more than about 5 to 10 minutes on the computer. This time may vary according to the speed of the printer.
5. As each student completes his or her plan, you should check it for completeness. Place your initials in the "OK 1" blank and assign the student with a user sequence number. This number is the order in which the students will use the computer.
6. Spirit masters can be placed in most printers and then multiple copies can be made for distribution if needed. If the "paper out" signal comes on during the last part of the printing, you may need to carefully slip an extra sheet of paper in below (to extend) the master. Using spirit masters with Print Shop can enhance handouts.

Instructional Strategy

The instructor will explain and demonstrate the use of Print Shop software. All product options will be displayed. Appropriate materials and equipment will be organized in advance to maintain student focus and maximize time. The instructor will monitor the activity to ascertain students' understanding and participation. Closure will involve a display and evaluation of all end products.

Equipment/Supplies

1. Apple IIe computer and monitor
2. Disk drive (two preferred)
3. Dot-matrix or laser printer and paper
4. Print Shop program disk by Broderbund Software, Inc.
5. Printout of all graphics, borders, and fonts available for students' use
6. The Print Shop Companion from Broderbund Software, Inc., a miscellaneous graphics disk (optional)

Evaluation Key
Each student's printout should be evaluated on the following criteria:

1. Following the Print Shop Plan Sheet (Does the print match the plan?)
2. Imagination/creativity (Does the end product look like everyone else's?)
3. Balance (Is it pleasing to the eye?)
4. Spelling

Modifications for Handicapped, Disadvantaged, and LEP Students
This activity can be easily modified to meet the needs of special students. Teaming special-needs students with non-special-needs students is one method of ensuring that they can participate in the activity.

PRINT SHOP PLAN SHEET

OK 1 ____ For use with Print Shop Software OK 2 ____

User Sequence ____ Date ____

All students must use this form to plan their work before using the computer. This should save time on the computer and allow students to use it more efficiently. This form must be *checked* by the instructor *before* and *after* the work is completed. The Print Shop disk goes in Drive 1, and all other disks use Drive 2.

Complete all necessary information.

NAME ______________________________ DATE ______________________________

Type of work (circle one): Greeting card (B1, G1, F1); Sign (B1, G1, F1); Letterhead (B2, G2, F2); Banner (requires special permission)

Border 1 _____	(which disk?)	☐ Print Shop_______	☐ Companion______	☐ Other______
Border 2 _____	(which disk?)	☐ Print Shop_______	☐ Companion______	☐ Other______
Graphic 1 _____	(which disk?)	☐ Print Shop (by number only)____________		☐ Other______
Graphic 2 _____	(which disk?)	☐ Print Shop (by number only)____________		☐ Other______
Font 1 _______	(which disk?)	☐ Print Shop_______	☐ Companion______	☐ Other______
Font 2 _______	(which disk?)	☐ Print Shop_______	☐ Companion______	☐ Other______

Write your message on the bottom of this sheet. CHECK YOUR SPELLING!

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 19

PRINT SHOP

Activity Overview

In this activity, students will learn both the personal computer's importance in communicating ideas and its uses in designing and producing graphic arts. The materials produced in this assignment may be used to promote your program.

Challenge Statement

Desktop publishing through the use of personal computers is one of the greatest technological accomplishments in recent years. You will be given an opportunity to explore and create graphic designs with computer equipment and software.

Objectives

- To design and produce (print) graphic arts materials in the form of either a greeting card, sign, letterhead (stationery), or banner
- To understand the use of the computer to design and produce graphic arts materials

Vocabulary/Concepts Reinforced

- Boot
- Disk
- Graphic
- Menu
- Greeting card
- Sign
- Letterhead
- Banner
- Graphic arts

Equipment/Supplies

- Apple IIe computer and monitor
- Disk drive (two preferred)
- Dot-matrix or laser printer and paper
- Print Shop program disk by Broderbund Software, Inc.
- A printout of all graphics, borders, and fonts available for students' use
- The Print Shop Companion from Broderbund Software, Inc., a miscellaneous graphics disk (optional)

Introduction

During this activity you will be involved in using an Apple computer to create and print graphic arts materials. You will be using a software program called Print Shop. This program has become one of the most popular programs for the Apple computer because of its ease of use and great variety of applications. Individuals use the program to create cards for birthdays, baby announcements, invitations, and much more. They also create posters (signs) announcing garage sales, instructions for use in the house, special messages for family members or relatives, and other projects. The software can also be used to create personal or family letterhead for important correspondence. The possibilities this program offers in the area of graphics are endless.

Not only are individuals using this program, but businesses also are getting into the act. Company letterhead, sales promotion signs, promotional sales invitations, and even large banners can be printed using Print Shop. This is an inexpensive but valuable resource to any business.

Colored paper and/or colored ribbons may be incorporated into the designs to make the creations more eye-catching. Your imagination is your only limit once you learn the basics of how to use the software.

Procedure

1. If you have not had instruction on the care and use of the Apple computer, you must complete the instruction before you continue. You must know how to load and boot (start up) the computer before you start to use this program.
2. The first step in using Print Shop is to complete one of the Print Shop Plan Sheets furnished by your instructor. One sheet must be completed for each printed work. Using the Plan Sheet will save you time at the computer so that more work can be done by a greater number of students.
3. The greeting card requires borders, graphics, and fonts (B1, G1, F1) on the Plan Sheet. Signs, letterheads, and banners are illustrated on the Plan Sheet in the same manner (e.g., B1, G1, F1).
4. As your assignment you are to create a sign or greeting card that will advertise a course you are presently taking. This sign or greeting card should be such that if used as an advertisement or invitation, students would seriously consider enrolling in the course.
5. Each of you will present your end product to the class. Give a brief explanation of why you chose the course you highlighted in your activity.

Evaluation

Your sign or greeting card should be creative and imaginative in its conception. The graphics and wording should be tasteful and appropriate for the occasion. Any inappropriate graphics or wording will result in a poor evaluation by your instructor.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 20
(1 DAY)

HOW WELL DO YOU COMMUNICATE?

Essential Elements: 2, 12
TAAS Objectives: Language Arts: R 1–6
Mathematics: C 3; PS 1–4

Activity Overview

In this activity, students will learn the importance of accurate communication. One student will verbally describe an object as he or she builds it, while another student tries to build the object as described without seeing it.

Challenge Statement

Industrial technology students should develop a basic understanding of the principles of communication, as they are the basis of all design and production.

Systems Model

Resources
Material
Background information
Members of the class

Processes
Giving directions
Receiving and decoding information

Applications
Transmitting and receiving information
Communication

Impact
Communication

Interfacing with Other Disciplines

Language Arts: Students will understand the importance of using common terminology in expressing ideas.

Social Studies: Students will understand the importance of communication and the implications of both transmitting and receiving information as it is intended.

Critical Thinking Skills Reinforced

Application is used in relaying clear directions to the listener, whereas analysis is used by the listener to discern information. Synthesis is used to organize and assemble the blocks, and evaluation is used at the completion of the activity to determine accurate and efficient communication.

Teaching Tips

The students may need some help getting started with their descriptions. Instruction in descriptive geometry should precede this activity. Include definitions of *perpendicular, parallel, vertical, horizontal, incline(d), rod, cylinder, cube, square, rectangle, wedge,* and *cone.*

Instructional Strategy

Clarify terminology for students before choosing partners. After the initial structure building and evaluation, encourage students to communicate about terminology before repeating the exercise. Encourage students to transfer their new realization to other areas, including industry, medicine, the military, education, family relations, and foreign policy.

Equipment/Supplies

1. Two identical sets of building blocks with cones, wedges, cubes, rods, etc. (They should not be painted, or at least colors may not be used as descriptors.)
2. Table divider or some other means of separating two participants (The participants must *not* be able to see each other's set of blocks, but they must be able to hear each other.)

Evaluation Key

This activity probably should be used to reinforce previously learned information, with no grade issued; however, if this activity is assigned for a grade, you might use the scale below.

A = Objects "exactly" alike
B = Only one block out of place
C = Two blocks out of place
D = Three or more blocks out of place

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Teaming special-needs students with non-special-needs students is one method of ensuring that they can participate in the activity.

HOW WELL DO YOU COMMUNICATE?

Activity Overview

In this activity, students learn the importance of accurate communication. The activity involves one student verbally describing an object as he or she builds it, while another student, without seeing it, tries to build the object according to the other's description.

Challenge Statement

Clear and accurate communication is an important function in all aspects of technology. Through this activity, you will understand the dynamics of both sending and receiving information.

Objectives

- To describe objects more accurately using the principles of shape and size
- To say exactly what you mean the first time you say it when describing an object

Vocabulary/Concepts Reinforced

- Parallel
- Rod
- Cylinder
- Cube
- Wedge
- Cone
- Vertical
- Horizontal
- Incline

Equipment/Supplies

- Two identical sets of building blocks with cones, wedges, cubes, rods, etc. (They should not be painted, or at least colors may not be used as descriptors.)
- Table divider or some other means of separating two participants (The participants must *not* be able to see each other's set of blocks, but they must be able to hear each other.)

Introduction

Verbal communication is critical in all aspects of our society. To get an idea from paper to production and distribution takes communication. Mistakes are often made when we do not communicate using the same terms or we do not understand the terms used.

During this activity, two students will be involved in descriptive, verbal communication. One student will be "giving" the communication, and the other student will be "receiving" the communication. In other words, you will have one talker and one listener. When the exercise is completed, the students change places and repeat the procedure.

Procedure
First separate the building blocks into two *identical* sets of blocks. Each participant will receive one set of blocks. The participants then sit so they cannot see each other's blocks, with either a screen or a divider between them. Or they may just sit facing opposite directions (back to back). Each must have a flat surface on which to build.

One student will build an object while explaining the construction (using only descriptive words) to the other student. The other student is to try to build exactly the same object without ever seeing it. The process continues until all blocks are used. The second student may place blocks immediately after each step in the first student's description but *may not* speak or communicate in any way at all. Only the first student may speak.

After you have completely used all the blocks, compare structures. How many did you get right? Now discuss the definitions of *parallel, vertical, horizontal, perpendicular, incline(d), rod, cylinder, cube, square, rectangle, wedge*, and *cone*. Be sure you each understand what they mean. Now try the activity again.

Did you improve when you understood the terms and communicated better?

As a class, discuss the impact of verbal communication on industry, medicine, the military, education, family relations, and foreign policy.

Evaluation
To see how well you did, let's compare building block structures.

> If the listener's object was exactly like yours, "you both did great!"
> If the listener's object had only one wrong block, "Good job!"
> If the listener's object had two or more wrong blocks, "Try it again."

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 21
(3–4 DAYS)

INTRODUCTION TO FUTURING—COMMUNICATION SYSTEMS

Essential Elements: 1, 5, 6, 12
TAAS Objectives: Language Arts: RC 1–6
Mathematics: PS 2

Activity Overview

This activity is intended to provide students with a new and unusual experience in their study of industrial technology. Students will participate in a "futuring" project in which they will be given an opportunity to "forecast" and "design" a future-oriented technology system.

Challenge Statement

This activity will give your students the opportunity to forecast future methods of communication. Beyond the basic idea of futuring, an incidental ingredient allows students to develop a sense of creative thinking and to foster what may be termed "creative daydreaming."

Systems Model

Resources
Background information
Tools and equipment as needed
Miscellaneous materials

Processes
Design loop
Material handling
Cutting
Bonding
Shaping

Applications
Futuring
Creative thinking skills

Impact
Creative thinking skills
Futuring

Interfacing with Other Disciplines

Language Arts: Students will use oral and verbal communication skills to present their ideas to the class.

Mathematics: Mathematics skills may be used in ideas for future communication. Students will use measurement to construct models of ideas.

Science:	Students may use scientific principles to design their future communication system.
Social Studies:	Students will understand a basic, technical communication process that strongly impacts society now and in the future.

Critical Thinking Skills Reinforced

Students will be able to apply their present knowledge of communication systems to what may be future trends. They will be encouraged to design future systems of communication, analyze them for their effectiveness and societal impact, and predict implications associated with future trends in communication.

Teaching Tips

1. Lecture to present the topic to students.
2. Adjust the time frame to meet the needs of your students.
3. Encourage creative thinking by your students.
4. Discuss the importance of futuring and creative thinking with your students.
5. Create a bulletin board display that will help illustrate some of the topics created by students. Some of your students' creations could be displayed outside the lab where other students and teachers can see what activities your students are involved in.
6. Gather as many different resources as possible, such as issues of *Popular Science, Popular Mechanics, TIES* magazine, and other associated publications.
7. Record appropriate segments of the Discovery Channel program "Beyond 2000" for your students to view.
8. Arrange for a guest speaker to talk to your class about future trends in communication. Someone involved in the broadcast industry or telecommunications would probably have some useful insights into future trends.
9. Use group work.

Instructional Strategy

Challenge students by allowing them to relate the topic of their futuring to their own interests. Trigger creativity by providing futuristic pictures and magazine articles. Communicate clear expectations about behavior and end products. Monitor the class to ensure participation by all students. Throughout the activity, praise positive endeavors and avoid negative or restrictive comments. Encourage all students in the presentation process.

Equipment/Supplies

These will vary according to the type of presentation your students make. It is suggested that you make as many different types of materials available as possible.

Evaluation Key

Grade students on their participation and cooperation throughout the activity. They can also be evaluated on the quality of their presentations and presentation materials.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students.

INTRODUCTION TO FUTURING—COMMUNICATION SYSTEMS

Activity Overview

This activity is intended to provide students with a futuring exercise in which they select a system of communication technology and forecast what that system will be like in twenty years.

Challenge Statement

Students involved in technology education typically are challenged with the impacts of various technologies but are given little time to think about what the future implications of these might be. It is important that you not only understand various technological systems, but also think creatively and imaginatively about the technology's potential to improve your quality of life.

Objectives

- To discuss the importance of futuring
- To describe some of the positive and negative impacts of technology
- To develop a forecast for a specific type of technology

Vocabulary/Concepts Reinforced

- Futuring
- Futurist
- Forecast
- Values

Equipment/Supplies

- Varied according to student needs

Introduction

How often have you thought about the future? Do you ever think about what your life will be like in fifty years? If you are like most people, you are probably more concerned with what is going on in your life right now. Thinking of the future is important, however. It is important for your own well-being as well as society's well-being. It is particularly important for students to think about the future, because your generation is next in line to inherit what other generations have started. It may seem like a scary proposition, but it is a challenge that you will soon encounter and one which you should take seriously.

As you work through this activity and the several that follow, you will see that thinking about the future can be fun. As you become involved in "futuring," the term we will use to describe thinking about the future, consider the following analogy. Life is very much like sailing a sailboat. The boat is affected by different wind conditions, by the currents in the water, by the action of the ocean swells, and by the direction that the boat takes. Although the sailor has little control over the wind and the water, he can chart his course to make his journey as pleasant and smooth as possible. The direction he takes is his to control. By looking forward and thinking about what is ahead of the sailboat, he can steer clear of rough seas and heavy weather. The same idea applies to your own life; you are the captain of your own ship, and you have the ability to look ahead and steer a course in the right direction.

Our world is changing at an alarming rate. Today's technological advances are often developed in a matter of months rather than years. Did you know, for instance, that about 90 percent of all the scientists who ever lived are alive today? That is a staggering number when you think about all of the scientific knowledge we have today. Compared to the development of photography, which took about one hundred years from discovery to practical application, it only took three years to develop the transistor. This rapid expansion of knowledge has some very strong implications to be considered.

First, it is important to be able to forecast problems before they occur. While some elements of our technology are intended to help make our lives better, there may be various impacts of that technology that have the potential to create serious problems. For example, large oil tankers were developed to improve the efficiency of delivering crude oil, which in turn was intended to help keep fuel costs down. While this was in fact a good idea and worked pretty well as intended, few questioned the potential these large tankers had to spill a great deal of oil in the ocean if they suffered a hull fracture. The famous Alaskan oil spill and the resulting ecological disaster serve as a good example of how important it is to think about the potential of technological impacts on our future.

Secondly, not all advances in technology result in negative impacts. The workings of our space program, for instance, have provided us with an ever-increasing array of products and services that have had significant positive impacts on our lives. Improved communication systems, computer technology advancements, improvements to navigation systems, improved medical knowledge, and other scientific discoveries all directly impact our efforts in space exploration and technology. We must always weigh the positive impacts of technological developments against the negative impacts, and seek some common ground. Rarely will some sort of trade-off not be necessary.

A futurist is someone who studies past accomplishments and current trends and applies this knowledge to the possibilities that lie ahead of us. Futurists do not think about the future in terms of what *will* happen, but reflect on what *could* happen. They are more interested in the possibilities and choices that the future holds rather than predicting that something is inevitable. Futurists also believe that individuals can make a difference in what direction we are headed, and that we have both the opportunity and the responsibility to control not only our own futures but the future of our society as well. The futurist believes that we need to be imaginative, innovative, and inventive and look at our world in new and different ways. And, perhaps most importantly, the futurist believes that we should all be futurists.

Procedure

What might the future look like in years to come? How will things be different when you are an adult, compared to the things your parents use today? For the purposes of this activity, we are going to look into the future of communications and help you perform some futuring of your own.

First, your instructor will lead a discussion in some of the various types of communication technologies used today. There are many, including photography, graphic arts, computer graphics, computer-assisted drawing and design, telecommunications, radio, television, satellite communication, fax machines, and many others. Look at what these various systems are capable of doing today, and consider how rapidly some of these systems have been developed.

Secondly, put on your futuring cap, and consider what types of changes will possibly take place twenty years from now. Select one communication system, and prepare a presentation of what that type of communication system could potentially become in twenty years. Remember, think about the possibilities, be inventive, use your imagination, and put a little of your own design into this effort.

Your instructor will outline a time frame to follow and standards to use in making a presentation of your future communication system forecast. Use whatever resources you think you will need. Use whatever method of presentation you feel best to describe your ideas. It may be a model, a poster, a videotape, or whatever you think will best help present your ideas.

Evaluation

You will be graded on your participation and cooperation throughout the activity. You will also be graded on the quality of your presentation and presentation materials.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 22
(2 WEEKS)

GO/STOP/GO

Essential Elements: 1, 2, 6, 7, 13, 18
TAAS Objectives: Language Arts: RC 1–6; WC 1
Mathematics: C 1–4; O 1–4; PS 1, 2

Activity Overview

Students will show energy conservation by using braking energy to restart a vehicle after a five-second stop.

Challenge Statement

As pollution causes more health problems and our natural resources are being depleted, it becomes more important to make more efficient use of energy.

Systems Model

Resources
Tools/materials
Time
People
Money
Information
Energy

Processes
Design
Research
Drawings
Construction

Applications
Environmental concerns

Impact
Social
Fuel cost
Environment
Pollution

Interfacing with Other Disciplines

Language Arts: Students will make a problem statement and list pros and cons of their design.
Mathematics: Students will use formulas for energy, force, time, and distance.
Science: Students will learn principles of energy, force, time, and distance to solve a problem.

Social Studies: Students will understand social and environmental effects of a transportation system.

Critical Thinking Skills Reinforced

This activity will require the use of various levels of thinking. The design of the vehicle requires basic knowledge of energy, force, time, and distance. Analysis of data from these areas is necessary to apply to the design. The process of analyzing other students' designs and the data acquired through evaluation will allow students to make improvements on their designs.

Teaching Tips

1. Several lower-level design problems (rubberband car, mousetrap car, balloon car, etc.) should be given before starting this problem.
2. The student should have some experience in the use of hand tools and be familiar with a variety of materials.
3. A resource box containing materials listed under supplies would promote students' experimentation with different materials and methods.
4. Math and science teachers could be used as resources, or arrangements could be made for data to be sent to these classes for them to process.
5. Assign the activity as an individual assignment until each student has developed a possible solution.
6. Organize groups of three to five with a mixture of abilities.
7. Stress that something good about a design must be stated before a flaw may be pointed out.
8. Drawings may be done by hand or computer-generated.
9. Point out that a method that does not work may turn out to be not a failure but a solution to another problem.

Instructional Strategy

Maximize the amount of instruction time by having tools and equipment organized in advance. Motivate students by emphasizing the importance of energy efficiency in transportation. Monitor your students carefully to ensure 100-percent participation. The evaluation should include redesign and transfer of ideas.

Equipment/Supplies

1. Basic hand tools, including:
    - Hand drill or drill press
    - Handsaw, band saw, or table saw
    - Assorted hand tools
2. A Resource Box containing:
    - Sheet plastic of various thicknesses
    - Wheels
    - Pine or other suitable wood
    - Metal rods
    - 1/4-inch dowel
    - 1/2-inch plywood
    - Gears
    - Pulleys
    - String
    - Old toys that have wheels, gears, springs, etc.

Evaluation Key

1. Drawings and design should reflect the ability of the students.
2. All students should be responsible for a list of best and worst features, as well as data collected on the performance of the vehicle.
3. The only grades that should be shared by the group are the drawing of the team design and the vehicle grades.
4. Students should receive a grade based upon their contribution to the group.

Support Materials

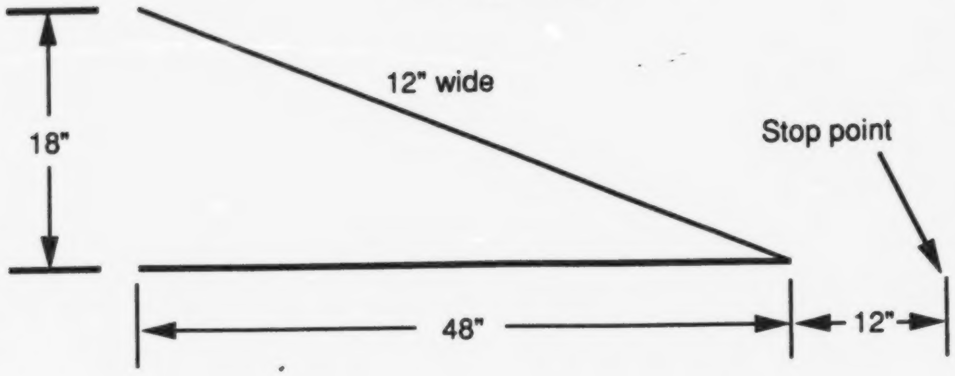
1. Macauley, David. *The Way Things Work.* Boston: Houghton Mifflin, 1988
2. *The Competitive Edge* (VHS cassette), West Glen Films
3. Transparency 22-1

Modifications for Handicapped, Disadvantaged, and LEP Students

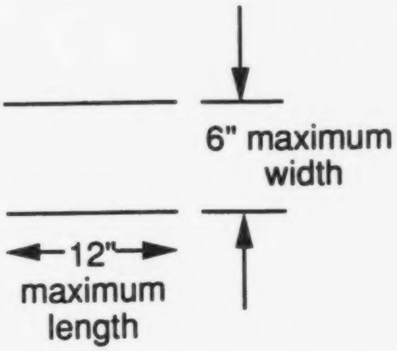
Grouping students by abilities should compensate for most handicaps. The degree of difficulty and time required to complete the activity can be changed by:

- Furnishing a vehicle with body and wheels.
- Having vehicle slow and speed up instead of stopping.
- Supplying kits with a variety of parts.
- Designing the method and not building it.

Go/Stop/Go Starting Ramp



Size of Vehicle



No limit on height of the vehicle

TRANSPARENCY 22-1

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 22

GO/STOP/GO

Activity Overview

Show energy conservation by using the energy normally lost in stopping a vehicle to restart it after a five-second stop.

Challenge Statement

As pollution causes more health problems and our natural resources are being depleted, it becomes more important for us to make efficient use of energy.

Objectives

- To recognize that energy is needlessly lost
- To demonstrate that lost energy can be captured and reused

Vocabulary/Concepts Reinforced

- Energy
- Energy conservation
- Law of Conservation of Energy
- Mechanical energy
- Light energy
- Nuclear energy
- Thermal energy
- Chemical energy
- Acceleration
- Deceleration
- Inertia
- Momentum
- Potential energy
- Kinetic energy
- Energy efficiency
- Friction

Equipment/Supplies

- Hand drill or drill press
- Handsaw, band saw, or table saw
- Assorted hand tools
- Hole saws, assorted sizes
- Pine or other suitable wood
- 1/4-inch dowel
- 1/2-inch plywood
- Assorted gears and pulleys

Introduction

Society today is desperately seeking new and improved methods of getting the most out of our energy sources. The automotive industry is being forced to produce cars that will get more miles from the same amount of energy. Many states are requiring automobiles to meet very strict emission standards. One method of improving fuel economy is to make use of energy that is normally lost in the form of heat. One such loss is the energy used to stop the automobile. If this energy could be harnessed and stored for later use, it could greatly increase the fuel efficiency of stop-and-go driving and at the same time cut down on the pollution being produced in our cities.

Energy recovery systems are already being used in air-conditioning/heating units. The use of heat pumps has increased the efficiency of many units. Electric cars have braking systems that use the braking energy to recharge the batteries. Think of the enormous amount of energy used to stop a city bus. If that energy could be captured and then applied to start the bus moving again, fuel consumption and pollution would both decrease.

Your task is to replace the standard brake system of a vehicle with a system that not only stops the vehicle, but also puts the energy into storage, holds it for five seconds, and releases that energy to make the vehicle start moving again. The vehicle will receive its initial energy from rolling down a 4-foot ramp. Your system should stop the vehicle 12 inches past the end of the ramp, allow the vehicle to remain still for five seconds, and then restart the vehicle in a forward path.

Procedure

1. Form a team with three to five members.
2. Design and build a vehicle that:
   a. has a maximum width of 6 inches and a maximum length of 12 inches;
   b. has four wheels;
   c. will stop 12 inches from the end of the ramp; and
   d. will use the energy from the braking device to start moving again after five seconds.
3. Each team member should research and develop a possible solution. (Sketches of the design should be made.)
4. Share possible solutions with each other.
5. List the best parts of each solution.
6. List the flaws of each solution.
7. As a team member, combine the best features and develop a design for a vehicle that will meet the criteria given.
8. Make appropriate drawings of the design and a list of materials.
9. Build the vehicle (one per team).
10. Test the vehicle.
11. Evaluate its performance.
12. Make improvements and run again.

Evaluation

Items to be completed for evaluation:

1. Problem statement
2. List of resources
3. Sketches of possible solutions
4. List of best features of team solutions
5. List of flaws of team solutions
6. Drawing of team design
7. Data on vehicle operation

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 23
(3 DAYS)

SOLAR ENERGY

Essential Elements: 7, 8
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4

Activity Overview

Students are introduced to the fundamentals of solar energy and its uses on earth. Students will participate in constructing a solar water still to apply this basic technological concept.

Challenge Statement

Among the topics associated with technology education, the study of basic energy concepts generally does not receive much attention. Developing a basic understanding of energy concepts is important, however, because they will continue to be some of the most important issues facing our society for many years to come.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Small-group, problem-solving activity
Solar water still

Impact
Solar energy technology

Interfacing with Other Disciplines

Language Arts:	Students will write a short report as part of their evaluation.
Mathematics:	Students will use the processes of adding, subtracting, dividing, and measurement calculations.
Science:	Students will understand the dynamics of solar energy.

Social Studies: Students will learn about the impacts of energy conservation and development of alternate forms of energy.

Critical Thinking Skills Reinforced

Students will use solar energy principles in building and demonstrating their solar stills. It will be necessary for them to analyize and extend the information presented into a practical application. Students will use elements of synthesis in organizing, planning, and constructing the solar still. They will self-evaluate and redesign if necessary.

Teaching Tips

1. Encourage craftsmanship in the handling of materials and construction of the still.
2. Review safety procedures for handling tools and materials as necessary.
3. Make a working example of the still to demonstrate the concepts presented.
4. If time permits, have students experiment with different types of materials.

Instructional Strategy

Open the class with a lecture to present the perceived need for alternative energy sources. Explain the concept of solar energy. Conduct a demonstration to help further understanding. Explain the concept. State your expectations for the activity. Use class discussion to check students' understanding and to clarify their questions about the actitivity. Use a variety of technical materials as a reference, if available. Students will self-evaluate through a written report.

Equipment/Supplies

1. Metal pan (A shallow metal pan can be constructed from galvanized sheet metal to form the internal pan. It should be constructed to be waterproof and have sides that are no more than two inches high. If your lab does not have the equipment or hand tools to form sheet metal, you can substitute shallow cake pans or cookie sheets. In either case, the pan must be painted flat black with a high-quality paint.)
2. Glass (size to be determined by your case size)
3. 2x4-inch no. 2 yellow pine
4. 2x2-inch no. 2 yellow pine
5. 1/8-inch Masonite bottom
6. Foil-backed batt insulation
7. 2-inch-wide flashing material for clamps
8. 3/4-inch sheet metal screws
9. Silicone caulk
10. Copper tubing
11. Plastic milk bottle for collecting distilled water

Note: The actual finished size of the solar still depends on the availability of materials. You can expect to distill about one gallon of water from each 10 to 12 square feet of still area.

Evaluation Key

Evaluate the students on cooperation and participation during the activity. Students will receive a completion grade for the written assignment.

Support Materials

Macaulay, David. *The Way Things Work.* Boston: Houghton Mifflin, 1988.

Modifications for Handicapped, Disadvantaged, and LEP Students
This activity can be modified to meet the needs of special students. If used as a team problem-solving activity, team special-needs students with non-special-needs students. Also, take advantage of resource teachers from the special education department who might be available to help during activity projects.

SOLAR ENERGY

Activity Overview
Students work in small groups to study the basic fundamentals of solar energy and build a solar water still.

Challenge Statement
One of the most important issues facing our world is the development of alternate forms of energy. Solar energy has been and will continue to be an important emerging technology. Developing a basic understanding of solar energy and its potential as an alternative energy source is important.

Objectives
- To understand the need for alternative energy sources
- To solve a problem through technology
- To understand the principles of solar water collection

Vocabulary/Concepts Reinforced
- Heliochemical
- Helioelectrical
- Heliothermal

Equipment/Supplies
- Metal pan (A shallow metal pan can be constructed from galvanized sheet metal to form the internal pan. It should be constructed to be waterproof and have sides that are no more than two inches high. If your lab does not have the equipment or hand tools to form sheet metal, you can substitute shallow cake pans or cookie sheets. In either case, the pan must be painted flat black with a high-quality paint.)
- Glass (size to be determined by your case size)
- 2x2-inch no. 2 yellow pine
- 2x2-inch no. 2 yellow pine
- 1/8-inch Masonite bottom
- Foil-backed batt insulation
- 2-inch-wide flashing material for clamps
- 3/4-inch sheet metal screws
- Silicone caulk
- Copper tubing
- Plastic milk bottle for collecting distilled water

Note: The actual finished size of the solar still depends on the availability of materials. You can expect to distill about one gallon of water from each 10 to 12 square feet of still area.

Introduction

Our country has experienced one of the most remarkable periods of technological growth and development of any of the modern industrialized nations. A major contributing factor to the success of our technological development has been the plentiful and relatively inexpensive supply of energy, particularly in the fossil fuels—coal, natural gas, and oil. Along with this great success, a positive impact, we have also created several negative impacts. Although these fuels have been easily obtainable, inexpensive to produce, and in most cases affordable, we were suddenly shocked during the first major energy crisis in the 1970s that energy resources were rapidly becoming scarce. As a result of this crisis, it became apparent that fossil fuels were being depleted more rapidly than they were deposited. This helped us realize that we need to both conserve our existing fossil fuels and develop alternate forms of energy.

Another impact of energy technology has been the manner in which energy has become a major political issue. Because the United States uses nearly one-fourth of the world's fossil fuel production each year, it has naturally become the focus of the world's concern for energy politics. Most of the available energy reserves are now in the control of large international corporations and energy cartels and these elements have steadily tightened their grip on the availability of energy products. Our own scientists have scrambled to help solve this dependency problem by developing alternative energy resources and better methods of conservation.

One of these alternative energy sources is our own sun. The sun produces massive amounts of energy each day and because it is expected to be around for about another four billion years, it can be considered one of the few constant renewable energy sources that we have. Solar energy can be divided into three primary technical areas, ***heliochemical, helioelectrical,*** and ***heliothermal.*** Each of these terms stems from the Greek word ***helios,*** meaning "the sun." The heliochemical process is what we commonly refer to as photosynthesis or plant growth. The helioelectrical process is a man-made process in which solar radiation is converted directly into electrical energy using silicon cells. Heliothermal devices are used to absorb solar radiation and convert it into heat energy.

Of these three solar energy systems, the heliothermal process is probably the easiest to model. Anyone who has walked across an asphalt parking lot in the heat of the day has experienced the general effect of heliothermal energy. The blackened surface of the asphalt causes the solar radiation to be absorbed and converted into heat energy. One of the oldest uses of solar radiation control happened when early humans collected salt from evaporation pools. Shallow pools of saltwater were allowed to evaporate, leaving a thin film of salt which could then be gathered and used in the diets of early humans. This effect is commonly referred to as solar distillation and is still a common method used today.

Solar distillation can also be used to produce drinking water. This is a process that was developed during the last century as a means of providing drinking water in areas where typical water wells are inappropriate. Solar distilling devices have been constructed to provide as much as 6,000 gallons of water daily in some locations. Study the diagrams at the end of this section, and observe how the basic principle of solar distillation works. Note that the basic still can draw moisture directly from the soil.

Procedure

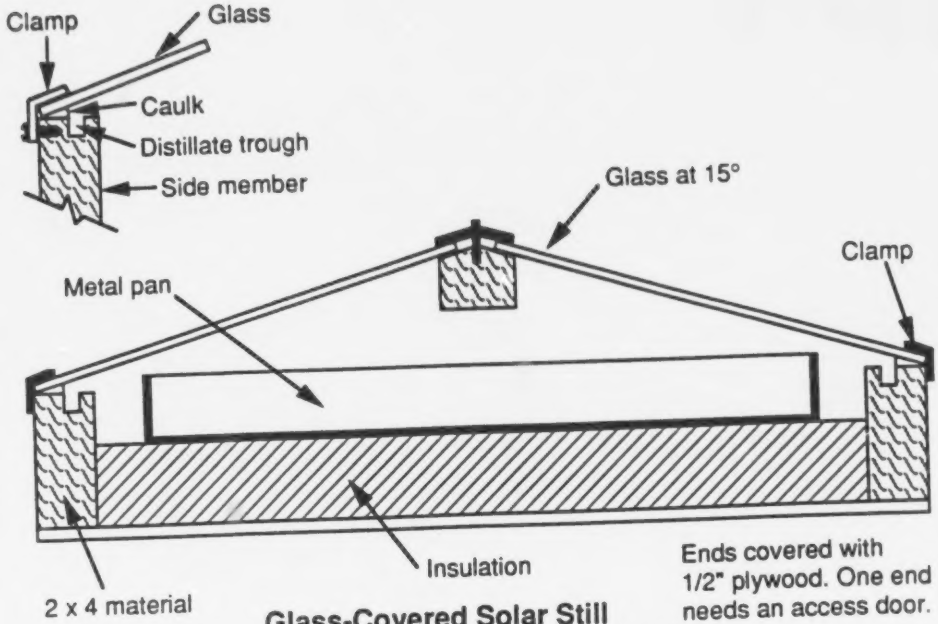
1. Your task for this activity is to study the diagrams, obtain the necessary materials, construct the solar still, and observe its operation. Note that your instructor may wish that your class work together to construct one or two solar stills and monitor their operation.
2. Upon completion of the solar still, plan to observe the distillation process for several days. Record the amount of water that your still collects and compare your results to others.
3. In a class discussion of the activity, have your group discuss the application of this type of device on a larger scale. Is it a practical means of obtaining water? What modifications might be made to the device to make it more efficient?

Evaluation

Turn in one page including:

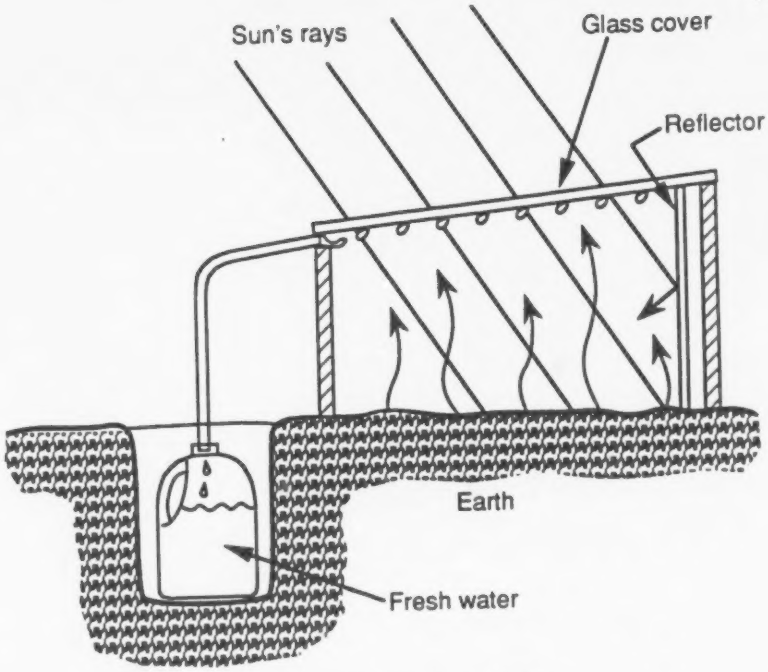
1. A record of water collected for three days
2. The answer to these two questions:
    a. Is a water still a practical means of obtaining water?
    b. What modifications might be made to make it more efficient?

As always, you will be graded on cooperation and participation during the activity.



Glass-Covered Solar Still
The dimensions vary according to local need.

ILLUSTRATION 23-1



Earth-Water Still

ILLUSTRATION 23-2

WIND ENERGY

Essential Elements: 1, 2, 7, 8, 10
TAAS Objectives: Language Arts: RC 1–6; WC 1–7

Activity Overview

Students will work in small groups to research and report on the use of wind as an alternate source of energy. Students will research the topic, make at least one visual illustration, and present their findings to the entire class.

Challenge Statement

Students enrolled in technology-related classes need to develop a basic understanding of the energy issues that our nation faces. Energy issues such as conservation and development of alternate forms of energy will become more important as our world supply of fossil fuels continues to deplete. The energy-related technologies will continue to offer employment opportunities for many years to come.

Systems Model

Resources
Group members
Reference information
Materials

Processes
Researching information
Designing a poster
Technical paper
Presentation of data is part of technology.

Applications
Small-group research activity
Reporting

Impact
Technical writing

Interfacing with Other Disciplines

Language Arts:	Students will conduct research to learn about wind energy and to build a wind generator and then write a technical report of their findings.
Mathematics:	Students will use math skills to design and build a wind generator.
Science:	Students will research and apply principles of wind generation created by solar radiation on the earth.

Social Studies: Through research and problem solving, students will be involved with an alternative energy source as a solution to our energy needs.

Critical Thinking Skills Reinforced

From varied research materials, students must determine what information is appropriate to the project and transfer it to the design and construction of a wind generator. They will evaluate their final product and make revisions as necessary.

Teaching Tips

1. Create a bulletin board display that illustrates the topic in relation to energy technologies.
2. Provide students with a variety of resource materials. You may want to have the librarian visit your class to discuss what materials are available to them.
3. If time permits, have students build a model of a wind-powered energy system.
4. Use this activity as either a small-group or individual project.
5. If possible, demonstrate a working model of a wind generator.
6. Arrange for a guest speaker to talk with students about the topic.
7. Arrange for a field trip, if possible, to view examples of wind energy generators.
8. Use student technical research papers and basic technical drawings to illustrate student research.

Instructional Strategy

Stimulate student interest by presenting current information on wind energy and its uses. Monitor the students throughout the activity to check for understanding and answer any questions they may have. Allow the students to evaluate each other and recommend alterations in their projects.

Equipment/Supplies

1. Research material
2. Pencils and paper
3. Drawing paper
4. Bulletin board display materials

Evaluation Key

Instructor evaluation of student performance on this activity should be based on participation in and completion of the activity.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified to meet the needs of special-population students. Arrange for a helping teacher from the special education department to assist special-needs students during this activity. Use the buddy system by teaming students with special needs with non-special-needs students. Pace the activity to meet the needs of your students.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 24

WIND ENERGY

Activity Overview

Students will work in small groups or individually to research and report on the use of wind energy as an alternative energy form. Students may also build a simulation model that helps to illustrate the operation of a wind generator.

Challenge Statement

Developing an awareness of energy systems and alternate forms of energy is important to any study of technology. You need to be aware of both the potential and the limitations of alternate energy-generating systems in order to understand the energy-related issues that they will face in the future.

Objectives

- To work individually or in small groups to research a technical topic
- To read and understand technical material
- To illustrate a technical process using a scale model
- To write a basic technical paper on a given topic

Vocabulary/Concepts Reinforced

- Alternative energy source
- Solar radiation
- Wind energy
- Wind generators

Equipment/Supplies

- Research material
- Pencils and paper
- Drawing paper
- Bulletin board display materials

Introduction

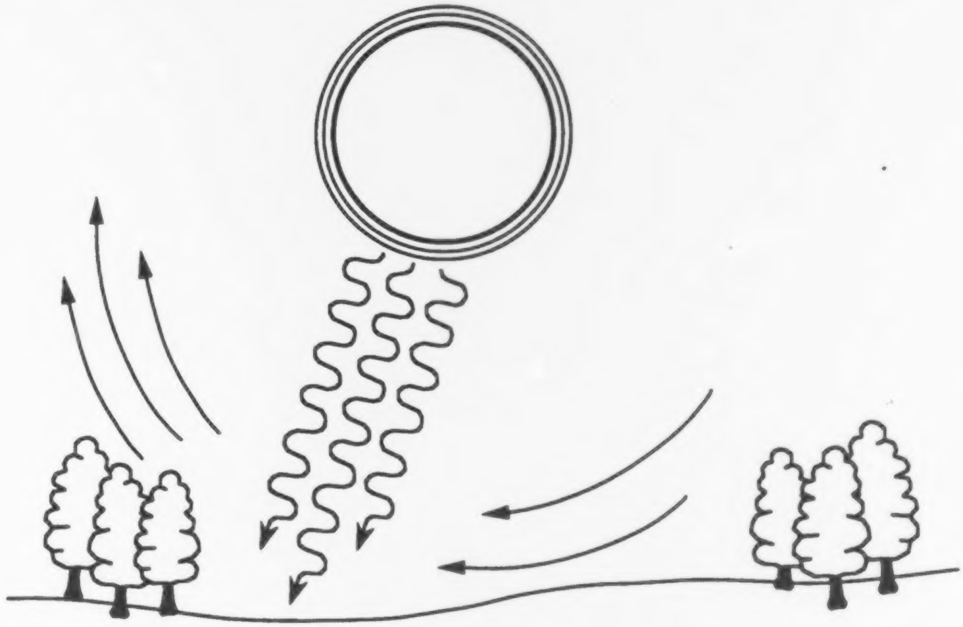
One of the greatest forms of unlimited energy is the wind. It is estimated that the amount of wind energy generated across the United States is about twenty five times the total amount of energy required by our nation for the same time period. The potential of wind as an alternative energy source is nothing new; it has been used since the seventh century. Its challenge lies in finding efficient ways to harness it. Generally, we think of wind generation as a means of producing both mechanical and electrical power. In this unit, we will look at the potential of wind energy and explore some of its positive and negative aspects.

How is wind created? Basically, wind is the result of solar radiation acting on the earth's surface. In effect, it is another form of solar energy. When solar radiation strikes the earth it usually causes an uneven heating and cooling effect in the air above the earth's surface. Where the ground or water surface is heated, the warm air rises, causing cooler air to move under it in the form of wind. As the sun's radiation weakens later in the day, the opposite effect occurs; cool air over the surface causes warm air to move in on top of it. The diagram below illustrates the cycle of wind generation caused by solar radiation.

The principal problem with wind-generated energy has always been its unpredictable nature. Wind energy is not obtained from a constant source, because winds change direction and intensity often. Any device designed to use wind energy must be able to adapt itself to changes in both direction and intensity. Older wind-powered machines were generally used to produce mechanical energy for grinding grain or powering machinery. Therefore, they did not need much wind speed in order to operate. Modern wind generators are used primarily to produce electrical energy and therefore need higher wind velocity to work. The minimum wind speed to generate electricity is 6 miles per hour. Constant wind speeds from 12 to 20 miles per hour are best.

Procedure
Your task for this activity is to research wind energy and determine its potential for providing an alternate form of electrical energy for your local area. In your research of the topic, determine what type of wind generator will work best to produce electricity. Construct either a simulated three-dimensional or low-relief model of your device. Be able to explain its operation and how it will serve to either replace or supplement existing electrical power systems.

Evaluation
You will be evaluated on participation in and completion of the activity. You will be expected to complete both a written technical paper on the topic as well as a simulation model wind-generation device.



Radiant energy heats the surface of the earth, heating the air. Warm, light air rises, producing wind.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 25
(1 WEEK)

BIOMASS ENERGY

Essential Elements: 7, 8, 10
TAAS Objectives: Languge Arts: RC 1–6; WC 1–7
Mathematics: C 1–4

Activity Overview

Students will work in small groups to investigate the possiblities of biofuels as an alternative form of energy production. Students will research some element of the topic and create a simulation low-relief model explaining the biofuel process they select. Each group will also be asked to prepare a short written technical paper supporting its presentation to the class.

Challenge Statement

It is important for students involved at any level of industrial technology education to become familiar with the topic of energy as it relates to modern technological development. Both energy conservation and the development of alternate forms of energy will continue to be an important issue facing all the industrialized nations of the world for many years to come.

Systems Model

Resources
Materials
Background information
Team members

Processes
Material handling
Model making

Applications
Small-group activity
Simulation
Technical paper
Model

Impact
Energy conservation
Alternate forms of energy
Biofuel technology
Modern technology

Interfacing with Other Disciplines

Language Arts: Students will conduct research and write a technical paper.
Mathematics: Math skills will be used to design and construct a technical model.

Science: Students will understand heliochemical energy and heliochemical energy production.

Social Studies: Students will be become familiar with the development of alternate energy sources and its impact on society.

Critical Thinking Skills Reinforced

Students will apply information from research to writing a technical paper and constructing a low-relief model. They will analyze written material to discriminate information and extrapolate ideas. Evaluation will take place in the concluding discussions of the topic.

Teaching Tips

1. Provide as much reference material as you can make available for student use.
2. Create a bulletin board display that helps to illustrate the topic.
3. Have students write a short technical paper related to their topic.
4. Check your regional service center for audiovisual materials related to the topic.
5. Use the lecture method to present the topic to students.
6. Use this activity as a small-group teamwork project.
7. Encourage the use of technical reference material.
8. Have students complete a written technical paper that will support the information that they present to the class.

Instructional Strategy

Supply the students with sufficient research information to clarify the topic. Check for understanding before specifying project expectations. Lead students in transferring research information to the hands-on activity. Monitor the class for involvement throughout the activity. Encourage reluctant students to get involved through teamwork and content clarification. Close the activity with an evaluation of the models and presentations of papers.

Equipment/Supplies

Varied according to how this activity is approached

Evaluation Key

Instructor evaluation of student performance on this activity is based on participation in and completion of the activity. Additional evaluation criteria may be added as necessary, including evaluation of models and posters according to specified standards and evaluation of technical papers.

Support Materials

Current-events magazines and energy-related articles

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified to meet the needs of special-needs students. If necessary, request a helping teacher from the special education department to assist special-needs students. You may wish to team special-needs students with non-special-needs students. Ensure that special-needs students are able to participate in the activity.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 25

BIOMASS ENERGY

Activity Overview

Students will work in small groups to investigate the possiblities of biofuels as an alternative form of energy production. Students will research some element of the topic and create a simulation low-relief model that explains the biofuel process that they have selected. Each group will also be asked to prepare a short written technical paper to support its presentation to the class.

Challenge Statement

Modern technology has created an unhealthy dependence on fossil fuels. This dependence has caused scientists and technologists to discover better methods of conservation as well as alternative forms of energy. You should become familiar with the various energy issues in order to better understand this complex issue and to possibly solve some of our energy concerns in the future.

Objectives

- To define the term *biomass energy*
- To describe the effect of photosynthesis as it relates to biomass energy
- To describe and discuss the use of biofuels

Vocabulary/Concepts Reinforced

- Biomass
- Photosynthesis
- Methane
- Methanol

Equipment/Supplies

- Varied according to instructor's needs

Introduction

Biomass fuels, also termed biofuels, are a source of renewable energy from living matter. Biofuels are different from fossil fuels in that they are considered to be renewable, whereas fossil fuels are not. Biofuels are a form of solar energy, because they are obtained from plants that absorb the sun's energy, convert it to chemical (heliochemical) energy through photosynthesis, and in the process of being eaten, decayed, distilled, or burned, pass this energy on to the rest of the world.

Every day, a massive amount of solar radiation strikes the surface of the earth. Scientists estimate that the total amount of solar energy reaching the earth on any given day is about one hundred times the total amount of energy used in the United States in an entire year. About half of this energy is reflected by the atmosphere, while most of the sunlight is absorbed, diffused, and scattered about. Only a small amount of solar radiation, less than one percent, is captured by green plants and converted via photosynthesis into chemical energy. Biomass energy occurs when plant matter is eaten, burned, or chemically converted into biomass energy.

Although not as efficient as solar, water, or wind devices, plants may hold solutions to our energy needs in the future.

Procedure

1. Work in small groups to research the topic of biomass energy. There are several issues related to biomass energy. Select one specific issue for your group report.
2. To supplement the research activity, construct either a low-relief model that simulates the topic, or design and draw a poster that helps illustrate the concept.
3. Present your group's research to the entire class.

Evaluation

Instructor evaluation will be based on participation in and completion of the activity. You may also be graded on your end product and your technical paper.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 26
(2–4 WEEKS)

RADIO-CONTROLLED SUNSHINE RACERS

Essential Elements: 1, 2, 6–8, 10–12
TAAS Objectives: Language Arts: RC 1, 3, 5; WC 1–4
Mathematics: O 1–4; PS 4

Activity Overview
Student teams will design, construct, and race solar-powered, radio-controlled vehicles around a prescribed course.

Challenge Statement
At the current rate of consumption, conventional energy sources will become more scarce and increasingly more expensive to produce. As the cost of conventional energy increases, alternative sources will be more in demand. For years engineers have found ways to heat water with sunlight and, in turn, to warm homes and businesses. The conversion of sunlight directly into usable electrical energy is one of the more attractive alternatives under study. Solar cells that do this are used extensively today for electric power in remote locations like weather stations and on board satellites in space. Experiments with more efficient solar cells are demonstrating that sunlight may soon be a practical power source for automobiles and airplanes.

This activity will require that each team experiment with the solar cells provided to determine how much power is available, and then design the most efficient vehicle to take advantage of this power. In addition to discovering solar power, students will explore radio control, servomotors, gear systems, basic electronics, and other related subjects as they attempt to solve the problems inherent in producing a solar-powered vehicle. In addition, students will be encouraged to consider the social and environmental impacts of this new power source.

Systems Model
Resources
Materials
Electronics
Background information

Processes
Design
Assembly
Research
Evaluation
Student teams
Tools

Applications
Transportation

Power
Domestic and industrial construction
Drawing

Impact
Clean air
Clean water
Public health
Employment
Competition

Interfacing with Other Disciplines

Language Arts:	Students will read related background materials to gather information and determine rules for racers. They will write a summary and evaluation.
Math:	Application of basic math skills is needed in the construction of the vehicle. Application of basic math in calculating gear ratio, steering linkage, turning radius, etc., is used in evaluating the race and redesigning the vehicle.
Science:	Students will apply energy conversion principles, including sunlight into electrical energy, electrical energy into mechanical energy, and transfer of mechanical motion through gears, pulleys, and other mechanical linkages.
Social Studies:	Students will participate in related reading, writing, and class discussions of the social and economic impacts of the scarcity of conventional energy as well as environmental impacts of continued consumption of fossil fuels.

Critical Thinking Skills Reinforced

Students will begin with a written statement of the problem and the objectives and concepts to be reinforced. This activity gives students an opportunity to develop definitions, elaborate the critical attributes, and generalize the principles within this statement, based on hands-on involvement. Students are given an opportunity to apply their understanding of concepts such as solar power, mechanical transfer of energy, and radio-control devices to the vehicles they construct. It gives students experience with the content being presented, emphasizing its importance. It provides each group of students with a challenge to build the best vehicle they are capable of building. They will analyze the outcome of the race and evaluate the effects of the various choices of materials and construction techniques on that outcome. The learning efforts of the students are reinforced when they find out which vehicle designs are most successful. From that, they will predict the effect of improved solar cells on society and the environment.

Teaching Tips

1. The scope of this activity could be either expanded far beyond what is presented here or confined merely to assembling the module components the teacher provides.
2. Subjects related to this activity would be excellent research and development projects for advanced students.
3. Results of these completed projects could either be presented on race day as exhibits or actually used to power or control vehicles.
4. Slower students may be challenged to build only the vehicle chassis and power them with motors and transmissions provided by the teacher.
5. Consider these subjects for expanded activities:
    - solar power
    - power trains
    - radio control
    - vehicle suspension

- electronics
- servomotors
- electronic timers
- power transformation
- CAD
- computer applications
- social impact
- efficiency of electric motors
- crystal frequency control
- vehicle steering systems
- wireless communication

6. The extent to which students are required to use computers to complete assignments will depend upon access to this equipment and your own experience. Modifications can easily be made to this activity that will allow assignments to be completed with conventional paper-and-pencil methods. However, the use of computers will motivate students and greatly add to this activity's value as a method of teaching technology.
7. The racetrack is best marked off on a sunny, nearly level parking lot or tennis court. A slight grade on part of the course can keep the race interesting. Racing around three or four pylons placed 20 or 30 meters apart will work fine; however, more creative courses may be more exciting for spectators. The area around the track should be kept as clear of obstructions as possible to allow for inevitable loss of control and crashes that can damage fragile solar cells.
8. The number of vehicles in each heat will be limited by the number of available radio kits (with separate transmitter channels) and by racetrack size. Since the criteria for winning this race is simply to accumulate the greatest number of laps in a given time, heats of one to four vehicles will work well.
9. A heat time of eight to ten minutes is about right to allow each team to race its vehicle around the track. In this amount of time, each vehicle should accumulate enough laps to determine place standing.
10. The cost of this activity can be controlled if each team does not have its own radio control set and solar power pack. It is only necessary for one team at a time to be on the racetrack; therefore, only one radio control set and one solar cell power pack are needed. A good option is for you or an advanced group of students to assemble the solar cells on a sturdy styrene panel in a series battery configuration. Design this unit so it can be used as an interchangeable power pack with facilities for quick mounting and connecting to different vehicles. Two or three of these power packs will be adequate for all of the teams to share. Each team can attach one of these power packs to its vehicle for test runs and on race day. If the servomotors and radio receivers are interchanged and shared by the teams in the same way as the solar cells, only one or two radio control kits are required. Extra radio control kits will be helpful if your budget will allow for them.

Instructional Strategy

Allow students to participate actively and successfully by combining individual and group activities in a hands-on design and production assignment that provides both formal and informal opportunities for you to evaluate student progress and provide appropriate feedback. Organize materials and equipment will be organized in advance to maximize instructional time. Both you and the students will evaluate student ideas to give feedback.

Equipment/Supplies

1. Computers and appropriate software
   This activity can be done without computers; however, its value will be increased greatly if the students are able to apply these modern tools and methods to solve problems.
2. Solar cells

Bright sunlight, efficient solar cells of good quality, and sufficient numbers of them to produce about 150 square inches of surface area will generate enough power for a good race (4 to 9 volts).

Suggested vendors:

- Siemens Solar Inc./4650 Adohrhn/Camarillo, CA 93010/(805) 482-6800
  This company sells a 4"x4" solar cell (product code #2141) for about $6 each. These cells are very efficient but fragile and should be mounted for protection. A series configuration of 8 or 9 (4"x4") works well. Attaching connecting wires to these cells can be difficult. Skillful soldering or some kind of homemade clip can do the trick.
- Pitsco/P.O. Box 1328/Pittsburg, KS 66762/(800) 835-0686
  Pitsco sells a variety of solar cells through its catalog. One good option is the #P300-772 for about $70. This is a tough, flexible 8"x10" battery of cells that is rated to produce 400 mA at 8.4 volts in very bright sunlight. One or two of these panels would be easy to work with and perform will enough.
- Seelye Equipment Specialists/913 State Street/Charlevoix, MI 49720/FAX (616) 547-5522 or Order (800) 748-0231
  SES distributes SunFlex solar panels of different sizes made by Sovonics Solar Systems. Call for information.

3. Radio control sets
   Kits are available from various sources. Pitsco sells a kit for about $80 that contains one transmitter, one receiver, and two servomotors that is perfect for controlling these solar cars and could be adapted for many other activities as well. *Special Note:* These little transmitter and receiver kits are sold with matching, plug-in crystals to control their operating frequency. When ordering more than one kit, specify that they should each operate on different channels so that they do not interfere with each other.
4. Electric motors, small gears, drive belts, wheels, etc., are usually available from salvage shops and can be scavenged by the students. Many of these items can also be ordered from Pitsco and other suppliers.
5. Miscellaneous building materials such as glue, tape, wire, strips of wood, foam core, Styrofoam blocks, and rubber bands will be needed.
6. Only common tools such as pliers, handsaws, soldering guns, and drills will be needed.

Evaluation Key

Each group should be evaluated at least three times throughout the activity. In some circumstances, more evaluations will be appropriate.

1. After procedure step #2, each team member should be graded on his/her ideas for the design of the vehicle (sketches, pictures, etc). It should be stressed that this will be an opportunity to evaluate students on *individual* performance.
2. After procedure step #5, team design proposals for the vehicle will be critiqued and graded before construction can start. Have the team collectively produce a well-organized notebook or portfolio containing its proposal. Stress that this is a *group* effort and a *group* grade. All team members are expected to contribute a fair share of the effort. Be alert for individuals that do not contribute and make appropriate adjustments.
3. After the final race has been run, a very important summary evaluation should be turned in by each team for grading. This evaluation will require the students to think critically about all of the vehicles in the race in light of the race results. This part of the activity will also require the students to consider the impact of solar energy on our society. They should answer these four questions with some degree of depth:
   - What did the best-performing vehicles have in common that made them good?

- What did the poorest-performing vehicles have in common that made them less effective?
- If you could do so now, how would you modify your vehicle to make it perform better?
- What effects do you think the development of more efficient solar cells will have on society and the environment?

4. Periodic progress checkups can provide supplemental grades and may be appropriate in some teaching situations with slower or poorly motivated students.
5. Extra credit for special projects related to this activity can be challenging to more advanced groups or individuals.

Support Materials

Books

1. Gary Starr. *The Solar Electric Book: A Practical Guide to How to Save Through Clean Solar Power.* Santa Rosa, CA: Solar Electric Publishing, 1987.
2. Robin McKie. *Solar Power.* New York: Gloucester Press, 1985.

Filmstrips

1. *Solar Energy Processes: Theory, Part I.* Pitsco catalog #P100-078. $45. This filmstrip deals with the fundamental physical principles involved in the study of solar energy. The structures of the sun and the reactions powering it are discussed. It also discusses the effect of the sun's radiation upon the earth.
2. *Solar Energy Processes: Theory, Part II.* Pitsco catalog #P100-089. $45. This filmstrip outlines the physics behind heat transfer through examination of the hardware involved in the measurement and collection of solar energy.
3. *Solar Energy Processes: Implementation.* Pitsco catalog #P100-113. $45. This filmstrip analyzes several existing research systems. Included are photographs of the various components and their relationships to the practical system along with a section on the economic and environmental practicality of solar energy systems.

Kits

1. Solar Experimenter Kit. Pitsco catalog #P300-768. $9.75. This kit contains one dc motor, one plastic propeller, one small solar cell, and a brief booklet.
2. Pitsco Solar Designer's Kit. Pitsco catalog #P300-770. $13.50. This kit contains enough materials for a team of two students to construct a very basic solar-powered vehicle that will move under its own power. This kit is very simple and can be assembled in only one class period.

Magazine articles

1. Woodward, Brian, and Chester Kyle. "New Solar Cells Win in Australia." *Popular Science,* February 1991.

Modifications for Handicapped, Disadvantaged, and LEP Students

- LEP students will be more successful if they are teamed with other bilingual students who are more accomplished English speakers. Make sure that all team members are comfortable with this arrangement.
- Consult with the special education teachers for help with difficult problems.
- Rearrange the furniture and equipment to provide easy access by wheelchair or crutches throughout the lab.
- A resource person may be helpful for students who need individual help.

SOLAR-POWERED VEHICLE RACE

Student Handout

General Description
Students will design, fabricate, test, and run a solar-powered, remote-controlled vehicle over a prescribed race course. The performance category of this event is a timed heat. The car amassing the greatest number of laps in a given time wins.

Description/Limitations of the Vehicle

- All vehicles are to be powered solely by solar cells (power to the drive wheels). Any component may be used. The only extra power on board may be the batteries for the remote-control radio receiver and servos. (These will be furnished by your teacher.)

- The collector array on each vehicle may not exceed 150 square inches of actual solar cell area.

- Solar cells may be arranged, wired, and mounted in any manner deemed most efficient by the teams.

- A team may use any motor it wishes, as long as its total power is derived from the on-board solar cells.

- There is no maximum or minimum weight for this vehicle. Remember, weight acts inversely on acceleration and available power.

- This event will be held outdoors in natural sunlight.

- Each team may enter only one vehicle in the competition.

SPECIAL NOTE: Vehicles may run with others on a prescribed track and are to be controlled with remote-control radio transmitters. The number of different transmitter frequencies available will determine how many vehicles can run in a given heat. Due to the layout of the track, vehicles (and solar cells) will be exposed to sunlight from varying angles.

RADIO-CONTROLLED SUNSHINE RACERS

Activity Overview

Your team will design, construct, and race a solar-powered, radio-controlled vehicle around a prescribed racetrack.

Challenge Statement

The sun is the power source for our world. In this activity you will convert some sunlight into electricity and then convert it again into mechanical energy to power your vehicle around a racetrack. You will also learn how you can steer your vehicle by radio control.

Objectives

- To work together as a productive team
- To develop the concept of converting sunlight into electrical and mechanical energy
- To transfer mechanical motion through gears, pulleys, and other common linkages
- To apply radio-control systems for the purpose of steering a vehicle
- To discover solar power as a clean, practical, alternative source of energy that can replace environmentally destructive fossil fuels in many applications
- To experiment with new materials and processes carefully
- To evaluate the results so that product improvements can be made

Vocabulary/Concepts Reinforced

- R/C (radio control) transmitter
- R/C (radio control) receiver
- Vehicle suspension systems
- Environmental impact
- Crystal frequency control
- Vehicle steering systems
- Mechanical advantage
- Power transformation
- Parallel and series circuits
- Energy conversion
- Solar cell
- CAD
- Spreadsheet
- Word processing
- Power train
- Social impact
- Servomotor
- Motor efficiency
- Basic electronics

Equipment/Supplies

For all teams:

- 150 square inches of solar cell surface area
- R/C receiver
- R/C transmitter
- Soldering gun with solder

For each group:

- SPST switch
- DC motor hookup wire
- Connectors
- Assorted materials needed to construct vehicle (ask instructor for help)

Introduction

In recent years, the rising cost of conventional fossil fuels and the environmental impacts of burning them have caused engineers to look for alternative sources of power. One of the more promising new technologies is the development of efficient solar cells. In this activity, you will convert sunlight directly into electricity using solar cells.

You are to design, fabricate, test, and race a solar-powered, remote-controlled vehicle. The remote control of your car will be accomplished using radio control sets and servomotors provided by your teacher. An array of solar cells to power your vehicle will also be provided by your teacher. Your task is to design the most efficient vehicle possible using this equipment.

The performance category of this event is a timed heat in which the vehicle amassing the greatest number of laps in a given time period wins. Your design should be carefully thought out, constructed, and tested before race day. Poorly crafted entries often are unable to complete the race due to breakdown on the track. Good luck!

Procedure

1. One member of your race team should read the rules of this competition aloud. (Your instructor will give you a handout outlining these rules.) The team should take the time to discuss and be sure all are in agreement as to the meaning of the rules before proceeding.
2. Working alone, each team member should prepare to present his or her ideas for the vehicle design to the other team members. Rough sketches, pictures from magazines or books, and crude models will be helpful when communicating your ideas. (The teacher will grade this procedure.)
3. Team members should share their design ideas and experiment as much as possible. Try out different chassis, steering systems, drive trains, motors, and solar cell configurations.
4. Evaluate the results of your experiments carefully. List strengths and weaknesses of each design idea. As a team, combine the best ideas and develop the best design to solve the problem.
5. As a team, produce drawings, procedures, and a list of materials that will be needed to build the vehicle. These drawings and lists will be referred to as your team's "design proposal."
   - Provisions for mounting the battery of solar cells must be included in all vehicle designs. Look carefully at the battery before you make your final chassis designs and ask your teacher for advice.
   - Your drawings should be complete and detailed enough to fully describe the vehicle's construction. CAD software may be used to produce these drawings using standard drafting practices.
   - Your procedures should be a step-by-step, ordered list of what will be done to construct your vehicle. This is best done with the aid of a word processor.

- Your materials list can best be done on a spreadsheet with a computer. List all of the materials needed as row headings, and put the estimated quantities for each item in an adjacent column. Your teacher will show you how to program the computer to calculate cost. (The teacher will grade this procedure.)

6. Build the prototype vehicle. Using a copy of the step-by-step procedures taken from your proposal as a guide, do each step and place a check mark beside it when it is accomplished. If unforeseen problems occur, ask your teacher for help. Procedural changes may be made if they meet with your teacher's approval. This is a good time to remember that this vehicle must be durable if it is to win the race. Poor craftsmanship can cause a breakdown on the track and keep an otherwise well-designed vehicle from winning.
7. Test run the vehicle, evaluate its performance, and make those design modifications needed to produce the best possible race vehicle before race day. Don't forget to update your drawings to reflect your revisions.
8. After the race is over, your group should critique all the vehicles' performances and write a summary evaluation. This evaluation should answer these four questions:
   - What did the best-performing vehicles have in common that made them good?
   - What did the poorest-performing vehicles have in common that made them less effective?
   - If you could do so now, how would you modify your vehicle to make it perform better?
   - What effects do you think the development of more efficient solar cells will have on society and the environment?

Evaluation

Your group will be evaluated three times as you progress through the activity.

1. After procedure step #2, each team member will turn in his/her design ideas for the vehicle (sketches, pictures, etc.) for a grade.
2. After procedure step #5, your final design proposal for the vehicle will be critiqued and graded before construction of the prototype can begin.
3. After the final race has been run (procedure #8), a summary evaluation should be turned in for grading.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 27
(2–3 WEEKS)

RUBBER-BAND-POWERED VEHICLE

Essential Elements: 1, 2, 7, 10, 12–14
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity is designed to increase student problem-solving ability, and to reiterate the role problem solving plays in all technological advancement. Students will receive identical components and materials to work with. From the materials provided, they will design and construct a vehicle that will travel a predetermined distance, powered only by a rubber band, spring, or a device with elastic properties.

Challenge Statement

Basic problem-solving activities are inherent features of industrial technology education. Students enrolled in the Technology Systems course should be presented with a wide variety of problem-solving activities. This broad-based approach not only provides students with a variety of problem-solving activities, but also helps strengthen their creative thinking skills.

Systems Model

Resources
Materials
Tools and equipment
Background information

Processes
Design
Pattern making
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Problem-solving activity given with specifications

Impact
Problem solving
Creative thinking
Industrial activities

Interfacing with Other Disciplines

Language Arts: Students will read related background materials to gather information and determine rules for racers. They will write a summary and evaluation.

Math: Applications of basic math skills are used in the construction of the vehicle. Applications of basic math in calculating gear ratio, steering linkage, turning radius, etc., are used in evaluating the race and redesigning the vehicle.

Science: Students will apply energy conversion principles, including transfer of mechanical motion through gears, pulleys, and other mechanical linkages.

Social Studies: Students will participate in class discussions of the social and economic impacts of the scarcity of conventional energy and the environmental impacts of delaying development of alternative forms of transportation.

Critical Thinking Skills Reinforced

Students will apply the design loop in planning and designing the rubber-band-powered vehicle. Analysis and synthesis are used by students both in the design and fabrication of the vehicle. Students will reinforce, apply, and extend learned concepts through observation and evaluation of the various vehicles.

Teaching Tips

1. Introduce the activity with a discussion on the need for alternative forms of transportation.
2. Review the problem-solving model if it has been some time since the last problem-solving activity.
3. Encourage craftsmanship and neatness in the fabrication of the vehicle.
4. Review safety procedures for handling materials and equipment as needed.
5. Make a working example of a rubber-band-powered vehicle and demonstrate it to the students.
6. If possible, have students experiment with different kinds of materials.

Instructional Strategy

Lecture on environmental concerns and the need for alternative forms of transportation to present the topic to students. Demonstrate a sample car to motivate students in their own designs. Continue class discussion to ascertain understanding, to generate ideas, and to reteach concepts, if necessary. Demonstrate techniques and procedures for machines and hand tools as needed to ensure the safety of your students. Encourage critical thinking skills to promote problem-solving skills and creativity. Lead students in the use of problem-solving techniques to work through the activity. Allow the students to appraise each car including their own to reinforce concepts.

Equipment/Supplies

1. Drill press or hand drill
2. Scroll saw or jigsaw
3. Assorted hand tools
4. Safety equipment as needed
5. Wood, sheet metal, plastic as needed for body parts
6. Dowels or metal rods for axles
7. Rubber bands
8. Wheels

Evaluation Key
Evaluation of student performance on this activity will be based on participation in and completion of the project. You will also evaluate your students on how well their vehicles meet the standards you set.

Modifications for Handicapped, Disadvantaged, and LEP Students
If needed, a resource person can be made available to help you in the lab area. Have special-needs students scheduled into your smaller classes. Use the "buddy system" to team special-needs students with non-special-needs students. Check permanent record files for ways of handling instruction for students in question.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 27

RUBBER-BAND-POWERED VEHICLE

Activity Overview

You will work either independently or in small groups to design, build, and test a rubber-band-powered vehicle. You will receive identical components and materials to work with in order to design and construct a vehicle that will travel a predetermined distance, powered only by a rubber band, spring, or other device with elastic properties.

Challenge Statement

Problem solving is an important skill that you need to have in order to be productive and innovative in all parts of your life. This activity is designed to increase your problem-solving ability and your understanding of the role problem solving plays in all technological advancement.

Objectives

- To identify and define a given technical problem
- To set goals and identify criteria for a problem
- To generate alternative solutions for the problem and consider limitations
- To select an optimal solution for the problem
- To choose appropriate resources
- To implement the desired solution
- To evaluate the results and make modifications to improve a solution
- To safely operate the tools, machines, and technology systems needed to construct the final product
- To transfer knowledge acquired to related problems or activities

Vocabulary/Concepts Reinforced

- All technological innovations are in essence systems of technology.
- Human interaction with resources produces technology systems.
- Technological systems are formalized methods used to solve problems.
- The design process and brainstorming are effective methods used to solve problems.
- Recognition of technology limitations is necessary in manufacturing.
- The use of models for testing and design aspects is an important part of finding solutions.
- Compromising to best meet specific design criteria is often necessary in industry.
- Group responsibility and teamwork will produce the best results.

Equipment/Supplies

- Drill press or hand drill
- Scroll saw or jigsaw
- Assorted hand tools
- Safety equipment as needed
- Wood, sheet metal, plastic as needed for body parts
- Dowels or metal rods for axles
- Rubber bands
- Wheels

Introduction

How do inventors develop and design some of the greatest items in the world? Where do they start, and what criteria do they follow when developing a new idea or item? An inventor's or designer's most valuable "tool" is the ability to "problem solve." Problem solving can be done in many ways; however, a method most commonly used to solve design problems is the design process. By following each step of the design process carefully, anybody can design and produce an idea. The design process works well for solving technology problems, because it relates to the technology systems model. This activity is designed to improve your problem-solving abilities.

Procedure

1. Your problem for this activity is to design and construct a rubber-band-powered vehicle out of materials in the lab. Your instructor may wish to divide the class into groups of three or four students.
   a. The vehicle may be powered by springs, rubber bands, or other materials with elastic properties. Determine what type of similar materials you will use for the vehicles. Talk to your instructor to make sure that the materials you want to use are safe and available for your use.
   b. Brainstorm ideas to design a vehicle that will travel as far as possible, powered only by some type of material with elastic or kinetic energy properties. Determine if your powered vehicle can be constructed safely and easily.
   c. Once you have designed your vehicle, you will need to continue the design process and build the vehicle. Construct the vehicle from the materials allowed, and modify the design in any way that will help to improve the function of the vehicle.
   d. You may wish to test your design from time to time as you construct it, so that modifications can be made with as little difficulty as possible. Record how far it traveled and how long it took to travel that distance. Compare your results to the other vehicles produced by your classmates.
   e. Make a list of ideas that would improve the vehicle you made. Make any necessary alterations you can to improve your car's performance.
   f. When all of the vehicles in the class are completed, have a contest to see which car will travel the furthest in the shortest amount of time.
2. Explain and compare your ideas for your design to the class in a discussion of the activity.

Evaluation

Evaluation of your performance on this activity will be based on your participation in and completion of the project. You will also be evaluated on how well your vehicle meets the standards set by your instructor.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 28
(3–5 DAYS)

CONVENTIONAL AND ALTERNATE ENERGY FORMS

Essential Elements:	7–9
TAAS Objectives:	Language Arts: RC 1–6; WC 5, 6

Activity Overview

This module is designed to be a springboard into other elements of energy technology. The module will provide a basis for student understanding of conventional and alternate sources of energy.

Challenge Statement

Developing a basic understanding of both conventional and alternate forms of energy is important to a study of the various technology systems.

Systems Model

Resources
Materials
Background information

Processes
Study vocabulary list
Student test
Crossword puzzle

Applications
Completing an individual student activity in which students learn about conventional and alternate forms of energy

Impact
Developing alternate forms of energy is an important issue facing our society.

Interfacing with Other Disciplines

Language Arts:	Students will conduct research to learn about energy and complete a test and a crossword puzzle.
Science:	Students will read about and study conventional and alternate energy forms.
Social Studies:	Through reading and discussion, students will develop an understanding of various energy sources.

Critical Thinking Skills Reinforced

Application of information is demonstrated through a written test and a crossword puzzle. Analysis is used to discriminate and differentiate various forms and sources of energy. The students will extend and apply information through discussion.

Teaching Tips

1. Conduct a class brainstorming session to establish a common definition for energy that all students will be able to define and explain.
2. Show a film that gives an overview of energy sources and uses in our society.
3. Conduct a pretest to determine student energy attitudes. At the end of the energy section, test again to see if attitudes have changed.
4. Plan a field trip to a nearby power plant.
5. Plan to have a guest speaker talk about local energy sources.
6. Have students construct a display that represents a form of either conventional or alternate energy source using computer graphics, freehand drawings, a collage poster, or model.

Instructional Strategy

Introduce the topic with a brainstorming session on the definition of energy to check for clear terminology. Introduce various energy forms through examples that are relevant to the students. Encourage all students to participate through class discussion. Give interesting examples through videos, current event information, or speakers. Evaluation will be in writing.

Equipment/Supplies

1. Glossary
2. Test
3. Crossword puzzle

Evaluation Key

Evaluation will be based on student performance on the test and completion of the crossword puzzle.

Test answers:

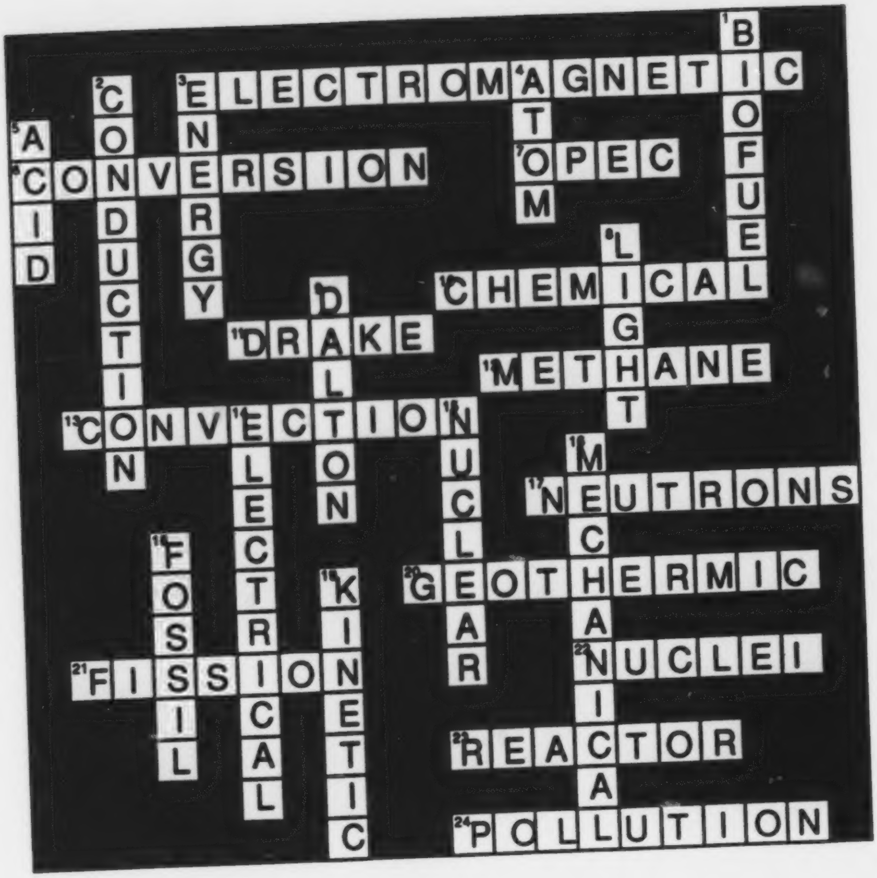
1. work, created, destroyed
2. potential, kinetic
3. mechanical, chemical, light, thermal, electrical, nuclear
4. hot, cold, conduction, convection, radiation
5. fission, atom, reactor
6. oil, gas, coal, 92
7. high consumption of energy in the United States
   OPEC price increases
   the Arab oil embargo of 1973
8. fossil fuels, geothermal power, nuclear power
9. wood power, biofuels, solar power, water power, wind power
10. Answers will vary.

Support Materials

1. Current events materials and videos
2. Your school librarian
3. Textbooks
4. Transparencies 28-1 and 28-2

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Teaming special needs students with non-special-needs students is one method of ensuring that they can participat in the activity.


1 BIOFUEL
2 CONDUCTION
3 ELECTROMAGNETIC
3 ENERGY
4 ATOM
5 ACID
6 CONVERSION
7 OPEC
8 LIGHT
9 DALTON
10 CHEMICAL
11 DRAKE
12 METHANE
13 CONVECTION
14 ELECTRICAL
15 NUCLEAR
16 MECHANICAL
17 NEUTRONS
18 FOSSIL
19 KINETIC
20 GEOTHERMIC
21 FISSION
22 NUCLEI
23 REACTOR
24 POLLUTION

TEST

1. Energy is the ability to do ______________, and it cannot be either ____________________ or __________________.

2. ________________ energy is at rest, and _________________ energy is in motion.

3. List the six forms of energy:
____________________, ____________________, ____________________,
____________________, ____________________, ____________________.

4. Heat flows from __________ to ___________ in three ways: ______________________,
______________________, and _______________________.

5. ___________________ is the splitting of the nucleus of an _______________________, and its reaction is controlled in a _____________________.

6. ______________, _______________, and _______________ are fossil fuels and supply _______________ percent of our energy today.

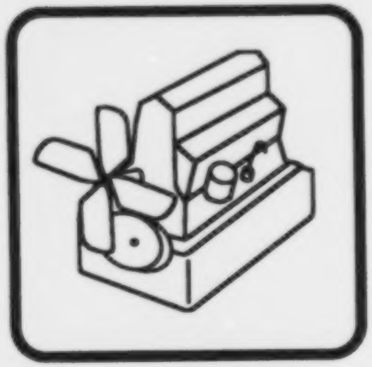
7. What three factors created the energy crisis of 1973?
____
____
____

8. Examples of nonrenewable energy sources are ______________________________________,
_____________________________________, and ______________________________________.

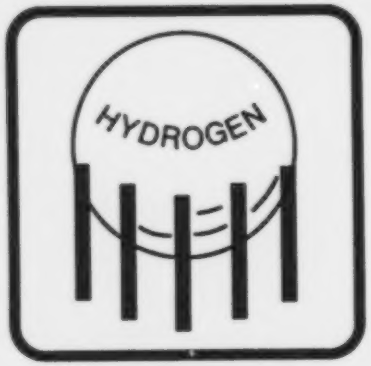
9. Renewable energy sources include ________________________, ______________________,
____________________, ________________________, ______________________,
____________________, and ________________________.

10. Write a short essay discussing energy conversion and energy storage.

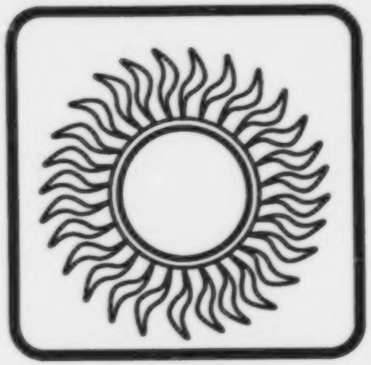
Principal Forms of Energy



Mechanical

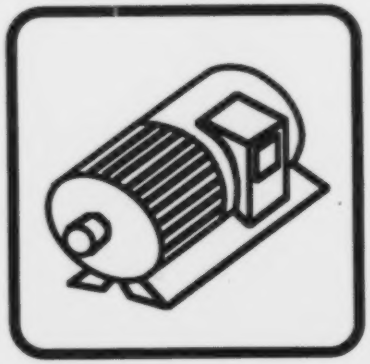


Chemical

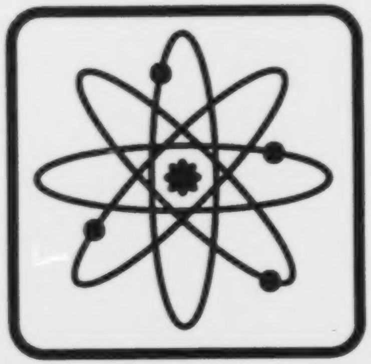


Light

Thermal



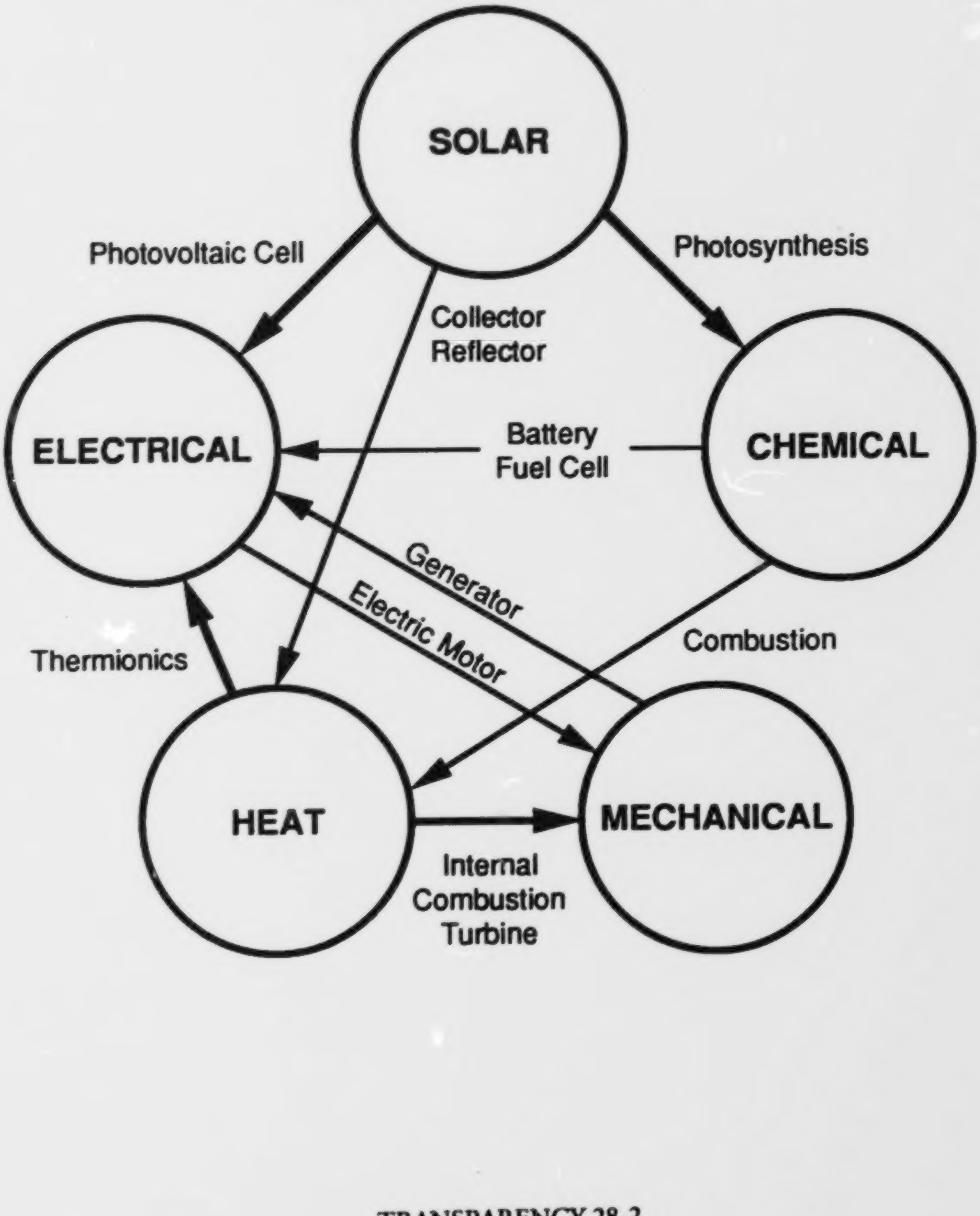
Electrical



Nuclear

TRANSPARENCY 28-1

Energy Conversion



SOLAR
ELECTRICAL
CHEMICAL
HEAT
MECHANICAL
Photovoltaic Cell
Photosynthesis
Collector
Reflector
Battery
Fuel Cell
Generator
Electric Motor
Combustion
Thermionics
Internal
Combustion
Turbine

TRANSPARENCY 28-2

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 28

CONVENTIONAL AND ALTERNATE ENERGY FORMS

Activity Overview
This activity will provide a basis for student understanding of conventional and alternate sources of energy.

Challenge Statement
Developing alternate sources of energy is and will continue to be one of the most significant problems facing our society.

Objectives
- To understand the history of energy and its importance to a growing technological America
- To become acquainted with past and present energy consumption and how it affects everyday life
- To understand the energy crisis and its causes and effects
- To appropriately define conventional and alternate forms of energy
- To explore present and future sources of energy
- To understand the relationship of energy to society

Vocabulary/Concepts Reinforced
- Acid rain
- Atom
- Biofuel
- Chemical energy
- Conduction
- Convection
- Deforestation
- Electrical energy
- Electromagnetic radiation
- Energy
- Energy conversion
- Energy crisis
- Fission
- Fossil fuels
- Fusion
- Geothermic
- Heat flow
- Kinetic energy
- Light energy
- Mechanical energy
- Methane
- Neutron
- Nuclear energy
- Nucleus
- OPEC
- Photosynthesis
- Pollution
- Potential energy
- Radiation
- Radioactivity
- Reactor
- Solar energy
- Thermal energy

Equipment/Supplies
- Glossary
- Test
- Crossword puzzle

Introduction
Energy has been a contributing factor in the development and advancement of our American society.

The United States historically has been rich in energy resources. Oil was discovered by Colonel Drake on August 27, 1859, in Titusville, Pennsylvania, and before that there was always a plentiful supply of wood and coal. Fuel was cheap then, and this cheap fuel allowed the United States to develop its industry. By 1900, America had grown to be an industrial giant, producing goods and services for 76 million people, and by 1980 for more than 226 million people.

The theory of nuclear energy was first discussed in 1808 by John Dalton. Enrico Fermi was the first to apply Dalton's theory with the construction of the first atomic pile in 1942. The first atomic pile generated 200 watts of power and ushered in the nuclear age.

With the development of energy, our lives began to change rapidly. We became a nation of energy consumers while we developed a strong technical base of knowledge. We created an advanced technological society while, at the same time, rapidly consuming natural resources and drawing energy sources from other countries.

ENERGY CONSUMPTION

Energy's availability to a society is always a major contributing factor to the advancement of that society. People use energy for everything; they heat their structures with energy and they use energy for production, transportation, communication, food, and leisure. As a society develops and grows, its need for energy increases. People build more and larger structures, they travel greater distances, and their need for energy-produced goods increases. The greater the population and its technology, the greater the need for energy. The United States consumes 35 percent of the world's energy but has only 6 percent of the world's population. Compare this to Japan's use of 4 percent of the world's energy with only 3 percent of the world's population.

YOU AND ENERGY

Every day you demand energy, you hear about energy, and you waste energy.

Energy supplies are becoming critical. We have become accustomed to using energy as we wish for work and leisure. We have not thought much about energy being wasted. Today the traditional sources of energy (fossil fuels) are becoming scarce. It is now everyone's responsibility to think about energy, conserving it, and finding new sources to meet our needs.

The United States currently uses 15.6 million barrels of oil daily. By 1995, usage is expected to rise to about 18 million barrels per day, assuming moderate increases in oil prices.

Texas, one of the more industrialized states, is very dependent upon energy as an energy developer and user. Not only are the citizens dependent on energy, but much of the state's economy is based on the production of energy. Energy, then, is a very important element of technology that we must understand and appreciate.

THE ENERGY CRISIS

In 1973, the United States experienced an energy crisis. The major cause of the crisis was that OPEC (the Organization of Petroleum Exporting Countries) raised the price of a barrel of crude oil from $3.00 to $11.50. About 45 percent of our current energy comes from oil, and we can easily see how OPEC's action caused a crisis for the United States.

Along with the increase in oil costs, the Arab oil embargo of 1973 contributed to the energy crisis. Now national attention was brought to the public on our high energy consumption and our limited resources. During the time of the embargo, we imported 3.5 million barrels of oil less per day than we needed to maintain our energy consumption. Long lines formed at gas stations where fuel supplies were limited. Gasoline prices rose along with heating and electricity bills. National movements began to improve the efficiency with which we use energy. Automobiles were to be made with miles-per-gallon regulations mandated, speed limits were lowered so vehicles would use less fuel, and car pools were encouraged.

FORMS OF ENERGY

What Is Energy?

Energy is the ability to do work. Work is often described as motion, support, or something that causes change. A few examples you might see every day would be air moving the leaves of a tree, a quarterback passing a football, the sun heating a puddle of water, or the chair that supports a person.

Types of Energy

There are two types of energy: *potential* energy and *kinetic* energy.

Potential energy is energy at rest, or the capability of an inactive object to produce motion. Examples of potential energy are a boulder sitting on a hillside waiting to roll or a spring wound up waiting to uncoil. Potential energy is stored energy in the form that is found—coal, oil, and wood are a few examples.

Kinetic energy is energy in the form of motion. Kinetic comes from the Greek word *inema* that means "motion." Examples of kinetic energy are balls rolling down a hill and heat being emitted from a fire. On occasion, kinetic energy may be temporarily stored, like a hot liquid in a thermos bottle.

The Principal Forms of Energy

Potential and kinetic energy are related to the form in which they are found. The principal forms of energy are:

1. *Mechanical energy.* When we think of mechanical energy, we think of machines. Machines are not the only things that have mechanical energy. Moving objects and objects that have the potential for motion or for interrupting motion have mechanical energy.
2. *Chemical energy.* Chemical energy is energy that is released from materials by a chemical reaction. The chemical energy is released when the materials change molecular structure. The food we eat is the fuel our bodies burn and convert into heat energy by chemical changes. Other typical chemical energy sources are fossil fuels, the battery, and photosynthesis.
3. *Light energy.* Radiant energy from the sun sustains plant and animal life. Light energy is electromagnetic radiation from the sun and is usually the stimulus to cause other forms of energy to develop.

4. *Thermal energy.* Thermal energy (heat) is also a form of electromagnetic radiation. You usually find light when heat is found. Thermal energy is the form of energy that is most important to our environmental control. Heat usually is a by-product of another form of energy: for example, mechanical energy (friction of one moving body against another), chemical energy (combustion of wood), light energy (sunlight hitting an object), electrical energy (electric heaters), and nuclear energy (atomic reactors). Thermal energy always travels from hot to cold. In the winter, heat travels from inside a structure to the outside, and in the summer, heat from the outside infiltrates the house. There are three methods of heat flow:
    a. *Conduction* is the flow of heat through a solid object. This is accomplished by heated molecules giving off their heat to adjacent molecules until all the molecules in the body are the same temperature.
    b. *Convection* is the flow of heat through a liquid or gas. Air is a gas and, therefore, a vehicle for convection. Warm air enters a room and rises because it is less dense than cold air; the cold air sinks and is returned to the furnace through the cold-air return.
    c. *Radiation* is the flow of heat from a light source by electromagnetic radiation. Heat flows from the sun to the furnace through the cold-air return.
5. *Electrical energy.* Electrical energy is energy that is developed when negatively charged electrons are drawn toward positively charged protons and flow through a circuit. This flow of electrons produces a magnetic field and heat energy. A magnetic field moving around or near a wire can also produce an electron flow and thus create energy.
6. *Nuclear energy.* Nuclear energy comes from the rearrangement of atoms. An action occurs that changes the nucleus of an atom, and great amounts of thermal energy are given off. Basically, there are two types of nuclear reactions: fusion and fission.
    a. *Fusion* is the uniting of two or more nuclei of atoms. The nuclei of light atoms are forced together to form a heavier atom, and large quantities of heat are released.
    b. *Fission* is the splitting of the nuclei of atoms. A large atom such as uranium is bombarded by neutrons, causing the nucleus to split into two parts. The splitting of one atom causes the rapid release of other neutrons to split the other atoms of uranium, thus creating a chain reaction. If uncontrolled, this chain reaction would create an explosion as in an atomic bomb. We control this chain reaction by slowing it down in a reactor and generating heat to produce other forms of energy.

SOURCES OF ENERGY

There are many sources of energy, but to make energy useful to a society it must be technologically easy for our machines to use; it must be easy to obtain; it must be plentiful; it must be easy to store; and it must be easy to transport.

Sources of energy may be classified into two basic categories, nonrenewable and renewable.

Nonrenewable Energy Sources

1. ***Fossil fuels.*** Oil, natural gas, and coal took millions of years for nature to produce by applying heat and pressure to dead organic matter. Fossil fuels have a very high carbon content and are, therefore, called hydrocarbons. It takes approximately 85 million years for nature to produce a fossil fuel. Even though the earth is producing new fossil fuels continuously, the time required for new fossil fuels to develop makes it a nonrenewable resource. At one time it was thought that we would deplete our supply of fossil fuel by the year 2000. Since then, new reserves have been discovered, and fuel consumption has been reduced by conservation and more efficient energy use. In 1978, 83 percent of U.S. energy consumed came from fossil fuels.
2. ***Geothermal energy.*** Less than one percent of today's energy comes from geothermal energy. This form of energy comes from tremendous heat that is trapped below the earth's surface. In some areas, natural-steam geysers provide the energy to operate steam-driven turbines to produce electricity. Hot water is extracted from the earth, then pumped through buildings and homes to provide heat. In the reverse process, cool water can be pumped through a heated area, receive heat from the source, and return to the earth and thus provide a cooling system.
3. ***Nuclear energy.*** Nuclear energy supplies about 5 percent of the nation's total energy requirements. Our nuclear energy is obtained from uranium.

The earth holds only so much uranium, heat, and fossil fuels. When the natural reserves held within the earth are depleted, or when what is left is no longer obtainable, the majority of today's energy sources will be gone.

Renewable Energy Sources

1. ***Wood.*** Trees are a renewable natural resource and are used by many individuals as an energy source or supplemental source. Wood is the source for about 3.6 percent of U.S. energy needs. In the late 1800s, wood supplied 90 percent of our heat. Today, the world population has become too large to depend on tree farming as a reliable energy source.
2. ***Biofuels.*** Biofuels come from once-living organic matter such as plants, animals, and human waste products. Organic materials are distilled to produce methanol for use as fuel or gasoline additives; others are "digested" by small micro-organisms to produce heat and methane gas.
3. ***Solar power.*** Solar energy is also a source of energy (about 2 percent) for the United States. Solar energy is used in two ways: direct and indirect. The direct usage of solar energy involves using the sun's electromagnetic energy to directly heat water or an enclosed space. The indirect usage of solar energy involves converting the sun's energy to electricity by solar (photoelectric) cells.
4. ***Water power.*** Tidal power can be used by capturing water at high tide in an enclosed basin. When the tide recedes, the potential energy in the stored elevated water can be used to drive turbine blades to generate electricity. The moving water in rivers and streams can also be used for an energy source in the same manner. Five percent of today's energy comes from water power.
5. ***Wind power.*** The wind has been used for centuries to drive windmills that grind flour and pump water. Today, less than one percent of our energy comes from wind-driven electric generators.

ENERGY CONVERSION

Energy cannot be created or destroyed, but it can be easily changed from one form to another. Energy conversion is happening all the time around us. The conversion of energy is a natural process in nature and has become a natural process in our technology. Engines, turbines, motors, and generators are examples of technology's energy convertors.

Besides our ability to convert energy, we have also developed systems to store energy. Batteries and fuel cells, the flywheel, eutectic salts, the hydrogen fuel cell, and rock, air, and water heat collectors are typical examples of energy storage systems.

ENERGY AND SOCIETY

The availability and cost of energy influence our lifestyle. Energy affects us all the time. It determines our heating, transportation modes, housing, and economics.

Today, there seems to be a trend toward smaller and more efficient automobiles, car pools, and mass transit systems. In buildings, there is an emphasis on reducing energy consumption by electricity and heat conservation and reducing heat loss and gain.

The economy is affected by the supply and cost of energy. Unemployment may be caused by a greater cost for imported energy than the dollars we receive for American-produced goods. The cost of energy may be a major expense in the production of goods for some high-energy-using industries.

Inflation, the decreased value of the dollar, is affected by the increased price of energy. As industry grows and expands, its demand for energy increases. The high cost of energy increases industry's expenses, which is passed on to the consumer as higher-priced goods.

One effect energy has on all of us, regardless of our socioeconomic position in life, is its impact on the environment. Should we keep the environment clean and safe, or should we trade off clean air and water for cheaper and more energy? Some of the tradeoffs are acid rain, smog, deforestation, destruction of the ozone layer, water pollution, and exposure to radioactivity.

Procedure

1. Study the glossary and other information provided in this activity.
2. When you are ready, ask your instructor for the student test; return it when complete.
3. Complete the crossword puzzle and turn it in.

Evaluation

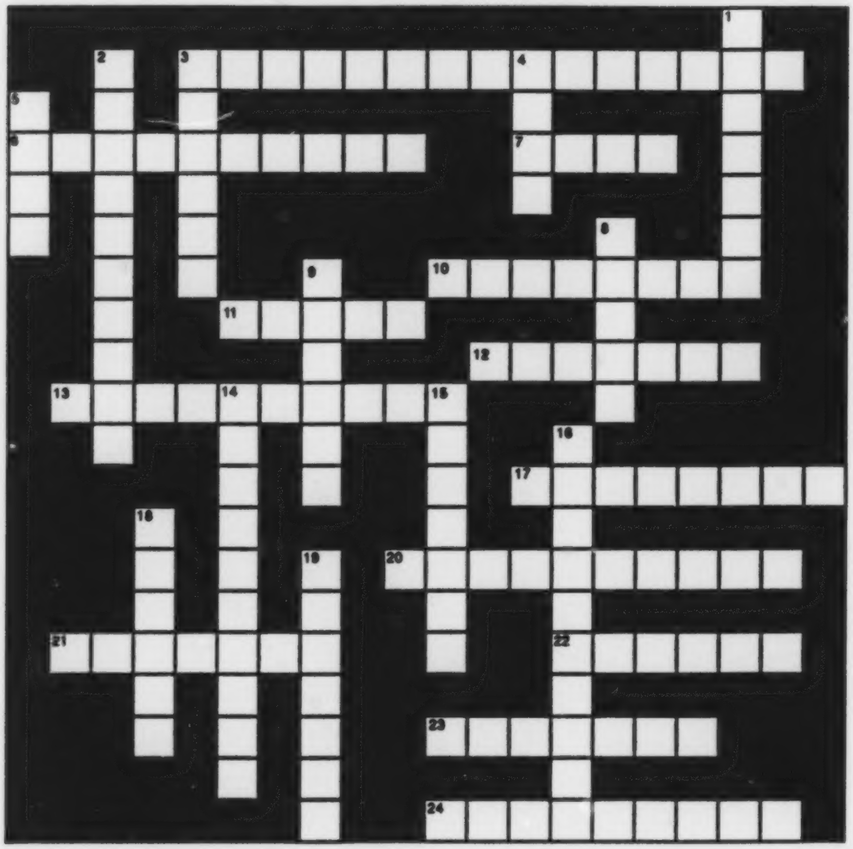
Evaluation will be based on your performance on the test and completion of the crossword puzzle.

GLOSSARY

Acid rain	rain with an acidic content caused by the incomplete burning of fuels or the burning of "dirty" fuels
Atom	the smallest particle of an element that can exist alone or in combination and that when split or rearranged will give off large amounts of energy
Biofuel	fuel that is made from organic matter
Chemical energy	energy that is stored and locked in elements such as growing plants, coal, oil, etc.
Conduction	the transfer of heat through a solid object
Convection	the transfer of heat through a gas or liquid
Dalton, John	the first individual to discuss the theory of nuclear energy in the year 1808
Deforestation	the process of clearing forests and vegetation
Drake, Colonel	the individual who discovered oil in Titusville, Pennsylvania, on August 27, 1859
Electrical energy	energy resulting from the flow and displacement of free electrons
Electromagnetic radiation	the transmission of energy released by solar fusion traveling through space to earth
Energy	the ability to do work
Energy conversion	the changing of energy from one form to another
Energy crisis	a situation that existed in the United States when there was a large demand for energy sources and a small supply of fossil fuels
Fermi, Enrico	the person who constructed the first atomic pile in 1942
Fission	the splitting of the nucleus of an atom, which produces two nuclei and releases large amounts of energy
Fossil fuels	fuels that come from once-living organic matter (e.g., oil, coal, and natural gas)
Fusion	the combining of two or more nuclei to form a new atom, which releases large amounts of energy
Geothermal energy	heat energy that comes from the heat stored below the surface of the earth
Heat flow	the transmission of thermal energy
Kinetic energy	energy in the form of motion
Light energy	radiant energy from the sun in the form of electromagnetic waves, which stimulates other forms of energy to develop
Mechanical energy	energy in motion or kinetic energy
Methane	a gas that is produced from an organic compound
Neutron	a particle in the nucleus of an atom that has neither a negative nor a positive charge
Nuclear energy	energy that is released from the splitting of the atom or the combining of two or more nuclei of atoms
Nucleus	the center portion of an atom
OPEC	Organization of Petroleum Exporting Countries
Photosynthesis	the chemical process by which plants absorb and store solar energy
Pollution	the contamination of air, water, and the food chain by unwanted and unhealthy by-products
Potential energy	energy that is stored or at rest
Radiation	the traveling of light and heat energy through space by electromagnetic waves

Radioactivity	the property possessed by some elements (as uranium) of spontaneously emitting rays or tiny particles by the disintegration of the nuclei of the atoms
Reactor	a strong enclosed container in which nuclear fission is controlled
Solar energy	energy from the sun
Thermal energy	heat energy

CROSSWORD PUZZLE



Across Clues

3. Radiant energy from the sun that is usually a stimulus to cause other forms of energy to develop
6. The changing of energy from one form of energy to another form of energy
7. The organization that raised oil prices in 1973 that helped cause the energy crisis
10. A form of energy found inside a battery created from a reaction
11. Person credited with discovering oil in 1859 in Titusville, Pennsylvania
12. A gas that is a product of a biofuel system
13. The flow of heat through a gas or a liquid
17. Particles used to bombard the nucleus of uranium to split the atom into two parts
20. Energy that comes from the tapping of the heat supply below the earth's surface
21. Nuclear reaction from the uniting of two or more nuclei of atoms
22. The center of an atom
23. The physical device used to control a nuclear reaction
24. An unwanted and undesirable by-product of some forms of energy

Down Clues

1. An energy source that comes from once-living organic matter
2. The transfer of heat through a solid object
3. The ability to do work
4. The smallest particle of a known substance that, when rearranged, will give up tremendous amounts of energy
5. The type of rain that is a pollutant from unclean fossil fuels
8. Form of energy radiated from the sun
9. Person who first discussed nuclear energy in the year 1808
14. Form of energy that uses negatively charged electrons that flow through a circuit
15. Form of energy that comes from the rearrangement of atoms
16. A form of energy involving moving objects
18. Fuel form that takes nature 85 million years to produce
19. Energy in the form of motion

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 29
(5 DAYS)

INTRODUCTION TO PATENTS, TRADEMARKS, AND COPYRIGHTS

Essential Elements: 1
TAAS Objectives: Language Arts: RC 1–6

Activity Overview

This activity is intended to provide students with a basic understanding of the three main devices used by the United States government to protect the rights of inventors or owners of creative works. Students will look at examples of patents, trademarks, and copyrights and be able to describe and discuss examples of each. Students will collect and create a display of examples from each area.

Challenge Statement

The creative efforts of individuals must be protected from unnecessary duplication and illegal copying by those who would intentionally take advantage of an invention or other work.

Systems Model

Resources
Background information

Processes
Collecting examples to represent each category

Applications
Patents
Trademarks
Copyrights

Impact
Controls and regulations related to patents, trademarks, and copyrights

Interfacing with Other Disciplines

Language Arts:	Students will study examples of products and books to locate written proof of patents, trademarks, and copyrights. They will give verbal descriptions of their examples.
Science:	Students can apply concepts of patents, trademarks, and copyrights to medicine and science.
Social Studies:	Students will become aware of patents, trademarks, and copyrights and their functions in protecting ideas and inventions.

Critical Thinking Skills Reinforced

Students will be able to apply their knowledge of patents, trademarks, and copyrights when analyzing different types of products and discriminate between patents, trademarks, and copyrights.

Students will be able to organize information relating to the three topics in a demonstration of their knowledge of patents, trademarks, and copyrights. Then they will be able to evaluate various products based on their relationships to patents, trademarks, or copyrights.

Teaching Tips

1. Adjust the time frame to meet the needs of your students.
2. Use a follow-up discussion to summarize the importance of governmental protection of inventions.
3. Lead a discussion on what industry would be like without these protections. How would the garage inventor protect his or her ideas from big industry without patents? How would we distinguish one company from another without trademarks? How would writers and artists protect their work without copyrights?

Instructional Strategy

Show students examples of patents, trademarks, and copyrights. Use graphic illustrations to help facilitate learning. Arrange for a guest speaker to talk to your class about one or all of these processes. Check with local legal associations for names of attorneys specializing in these areas who might serve as guest speakers to make the information more real. Obtain a video program related to patents, trademarks, and copyrights. Close the activity with an evaluation and discussion of student examples.

Equipment/Supplies

1. The teacher should gather several examples to help illustrate each of the topic areas, patents, trademarks, and copyrights.
2. It is suggested that materials be provided to develop a bulletin board display to help illustrate the topic.

Evaluation Key

Teacher evaluation should be based on participation in and completion of the activity. You will also grade the students on examples and presentations to the class.

Support Materials

Transparencies 29-1 through 29-4

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students.

Patent

Trademark

Copyright

Patent:

An official document securing to an inventor for a term of years the exclusive right to make, use, or sell his invention.

Trademark:

A distinguishing characteristic or feature firmly associated with a person or thing.

Copyright:

The exclusive legal right to reproduce, publish, and sell the matter and form of a literary, musical, or artistic work.

INTRODUCTION TO PATENTS, TRADEMARKS, AND COPYRIGHTS

Activity Overview
Students will explore the use of patents, trademarks, and copyrights to protect the inventions and creative works of individuals from being copied by others.

Challenge Statement
The creative efforts of individuals need to be protected from unnecessary duplication and illegal copying by those who would intentionally take advantage of an invention or other work.

Objectives
- To describe the basic differences between patents, trademarks, and copyrights
- To be able to analyze a product and describe how that product is most probably protected by governmental laws and regulations
- To be able to suggest which protective device should be used with a particular invention or piece of work

Vocabulary/Concepts Reinforced
- Patent
- Trademark
- Copyright

Equipment/Supplies
Examples of patents, trademarks, and copyrights

Introduction
The continued growth and development of our country is largely dependent on how well we maintain a leadership role in technological innovation and invention. Traditionally, the United States has been at the forefront of technological development and has been the primary source for new and emerging technology for the entire world. It is important, therefore, to expose technology education students to the processes of invention and innovation.

Invention and innovation are concerned with developing ideas that can be used to solve technical problems. Ideas lay the groundwork for solving problems and evolving inventions. One contributing factor to invention's success in our country is the protection afforded inventors from having their ideas duplicated or copied by others. The U.S. government has an agency whose purpose is to provide protection of ideas. The U.S. Department of Commerce's Patent and Trademark Office is responsible for granting this protection.

Patents are granted by the federal government to protect inventions for inventors. Patents grant the inventor the right to keep others from making, using, or selling an invention. The patent does not give the inventor the right to make or sell an invention, but rather to keep others from making or selling it. Patents are granted for a period of seventeen years, but only apply to the United States and its territories.

A trademark is a word, phrase, name, symbol, or picture that distinguishes one company or product from another. The U.S. Patent and Trademark Office registers trademarks to prevent others from using confusingly similar symbols to market products. Trademarks generally appear directly on the product or its container. A good example of a trademark is the name of a softdrink such as "Dr Pepper." The federal government protects Dr Pepper from others using a name or mark that could be confused by consumers as being the same product. In some cases, however, a name can be used if it does not create confusion. For example, a company can use the name Apple Auto Leasing and use an apple as its trademark without infringing on the trademark granted to Apple Computer.

A copyright is used to protect writings, artwork, recordings, photographs, film, and video creations from being copied. Copyrights granted to the owner extend from the creation of a piece of work for the lifetime of the owner, plus fifty years after the owner's death. Generally, works that are copyrighted are identified by the word "copyright," the abbreviation "copr.," or the symbol ©, and the name of the copyright owner. Copyrights are applied for and granted through the U.S. Copyright Office, Library of Congress, Washington, D.C.

Procedure

1. In the first part of this activity, students will bring one example to class to illustrate each of the categories described above. Students will present their example and describe whether it is protected by patent, trademark, or copyright laws.
2. In the second part of this activity, students will research and find either an article or actual object representing a new or emerging invention or creative work.

Evaluation

You will be graded on participation in and completion of the activity. You will also be graded on your examples and presentation to the class.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 30
(1–2 WEEKS)

THE INVENTION PROCESS—BASIC DESIGN AND MODELING

Essential Elements: 1; others depending on inventions
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1–5; O 1–4; PS 1, 2

Activity Overview

This activity provides students with a basic design activity. In this activity, they can either "invent" a device to perform a specific function or modify an existing device to improve its performance. They will also build a low-relief model of the device to help illustrate the mechanics of its operation.

Challenge Statement

Students need to have firsthand experiences in design activities to help them both realize the importance of the invention process and develop a sense of creative thinking.

Systems Model

Resources
Background information
Materials
Tools and equipment

Processes
Design loop
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Invention process
Basic design
Low-relief modeling

Impact
Invention process
Technology

Interfacing with Other Disciplines

Language Arts: Students will follow sequential directions to construct a model of an invention they design. They will give a verbal description of their invention.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement throughout this activity to design and build their model.

Science: Students may work with scientific concepts in solving a problem and meeting a need.

Social Studies: Students will become aware of the impacts and implications of new inventions on society. They will exercise creative energy to meet a need through invention.

Critical Thinking Skills Reinforced

Students will apply their basic understanding of the design process in this activity. They will determine needs, estimate materials, prepare basic drawings, transform materials, and demonstrate their design and modeling efforts. They will analyze problem information to determine a possible solution. Then they will plan, organize, design, and produce a working prototype of their invention. Students will evaluate their own design and modeling efforts and judge whether or not they have met design criteria.

Teaching Tips

1. Suggest design problems to those you feel are stumped. Inventions should be items that are really useful, e.g., a broom holder, tool rack, dustpan, etc. You might also consider having students modify an existing device to improve its performance or usefulness. Also, you could ask other staff members for possible suggestions the students might be able to use for their inventions.
2. Adjust the time frame to meet the needs of your students.
3. Encourage creative thinking by your students.
4. Demonstrate "low-relief" modeling to your students using foam core board. Select an object such as a desk lamp to demonstrate low-relief modeling.
5. Have a copy of David Macaulay's *The Way Things Work* available for students to review.
6. Use a follow-up discussion with your students to evaluate their understanding of the topics.
7. Allow students who are more comfortable working in a group the opportunity to do so. Monitor all groups carefully for full participation by all members.

Instructional Strategy

Lecture to present the topic to students. Demonstrate low-relief modeling technique to clarify instruction and set clear expectations. Use graphic illustrations to focus attention and create interest. Arrange for a guest speaker to talk to your class about design and product improvement to make the information more applicable. Obtain a video program related to design and modeling techniques to expand learning. Close the activity with a demonstration and explanation of all models.

Equipment/Supplies

1. Several sheets of foam-core board
2. X-acto knives
3. Pushpins
4. Hot glue guns
5. Brads
6. Drawing paper
7. Pencils

Evaluation Key

Teacher evaluation should be based on participation in and completion of the activity.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students. Students with physical handicaps, however, may have difficulty with some elements of this activity.

THE INVENTION PROCESS--BASIC DESIGN AND MODELING

Activity Overview

This activity is intended to provide students with a basic design activity in which they "invent" a device to perform a specific function and build a "low-relief" model of their design to help illustrate its basic operation.

Challenge Statement

Students need to have firsthand experiences in design activities to help them both realize the importance of the invention process and develop a sense of creative thinking.

Objectives

- To discuss the basic invention process
- To invent a basic device to perform some specific function
- To sketch a basic drawing to help illustrate an idea
- To develop a low-relief model to help demonstrate basic mechanical movement
- To discuss the importance of invention

Vocabulary/Concepts Reinforced

- Sketchstorming
- Low-relief modeling

Equipment/Supplies

- Foam-core board
- X-acto knives
- Pushpins
- Hot glue guns
- Brads
- Drawing paper
- Pencils

Introduction

The invention process depends on the creativity and imagination of the inventor. Inventors, the people who are involved in the invention process, are motivated to find and develop solutions to all types of technical problems. Inventors are not people who are particularly gifted and talented in math and science, although many inventions are the work of engineers and scientists. Many inventions result directly from someone simply finding a better way of doing something. The old adage "necessity is the mother of invention" is the driving force behind most of the great inventions throughout history. In fact, many inventions are created by "tinkerers" who simply discover better ways of doing things.

The first inventions were directly tied to human survival. Early people formed tools and weapons from sticks and stones to help in hunting animals and gathering food. The evolution of invention has its roots in these early instruments of survival. Humans had basic needs that they were able to solve through the use of various tools and weapons. Although they probably didn't understand the concept of the inclined plane, early humans certainly knew that by chipping a stone into a wedge shape they could kill animals, skin hides, cut wood, and fight their enemies.

Early inventions were the direct results of searching for solutions to problems. The invention process and the problem-solving process work hand-in-hand in that both are geared toward solving basic problems. Early inventors probably tackled problems with the same vigor that modern inventors use today. Many of the inventions patented today are basically improvements of inventions created long ago. The plow, for instance, was invented about 3500 B.C., somewhere in the Middle East, to improve crop growing. Although it was probably extremely crude by today's standards, it was the beginning of virtually all farm implements that are used today. Everyday items such as locks date back to ancient Egypt; water wheels and windmills date back to the first century B.C. The list goes on and on.

Did you know, for example, that the zipper was invented in 1891 by Whitecomb Judson, not as we use it in its present form, but as an improved method of tieing up boots? In 1926, the U.S. Navy became responsible for its present use, discovering it to be a better method for closing up flight suits. The Navy actually coined the term "zipper" that we use today.

Among the first forms of transportation were boats made by hollowing out tree logs. These crude canoes provided early humans with an efficient form of transportation as long ago as 8000 B.C. Archimedes, one of the most noted inventors of all time, is said to have developed the basic theory of flotation in about 200 B.C. He felt that material other than wood could be made to float. It is said that he made this discovery one day while taking a bath. He became so excited that he ran naked out into the street shouting "Eureka," which in Greek means "I have found it." Amazingly, it was not until about 1800 that inventors were able to apply this theory toward building iron ships.

We are all affected by the inventions of creative people. Every minute of the day we are all in contact with the inventions of some creative individual who found a need and set out to find a solution. Inventions are, for the most part, created to better our lives. Electric lights, processed food, automobiles, airplanes, shopping malls, televisions, compact disc players, etc., result from someone seeing a need and setting out to meet that need. Necessity, after all, *is* the mother of invention.

Procedure

After completing a discussion of invention and watching the demonstration of low-relief modeling, you are to work individually to create your own invention. You will also be asked to create a working model to help illustrate the basic mechanical movements of the device. The activity is intended as a creative experience for you and should be approached as if the invention would be used—as well it should.

Remember that the invention process is closely linked to the basic problem-solving process in that the need for an invention is usually linked to some type of problem.

The inventor perceives that a need exists, that is, a problem, and sets out to create some type of solution to that problem. So the first thing you need to do is determine a need for yourself or others. Use as many resources as possible. Use sketchstorming, brainstorming, and analysis of existing products that possess similar characteristics.

Because this activity is intended to be a creative experience, you will be given as much latitude as possible to develop your ideas. Obviously, your safety and the safety of others is important. Your instructor reserves the right to prevent dangerous activity from taking place.

The modeling aspect of this activity is simply a means to better visualize all or some of the mechanical operation of a device. Low-relief modeling is an ideal first stage in creating a complete working prototype. After a predetermined time set by your instructor, you will be asked to demonstrate your invention to the entire class. After everyone has demonstrated his or her invention, your instructor will lead a class discussion on creativity and the invention process.

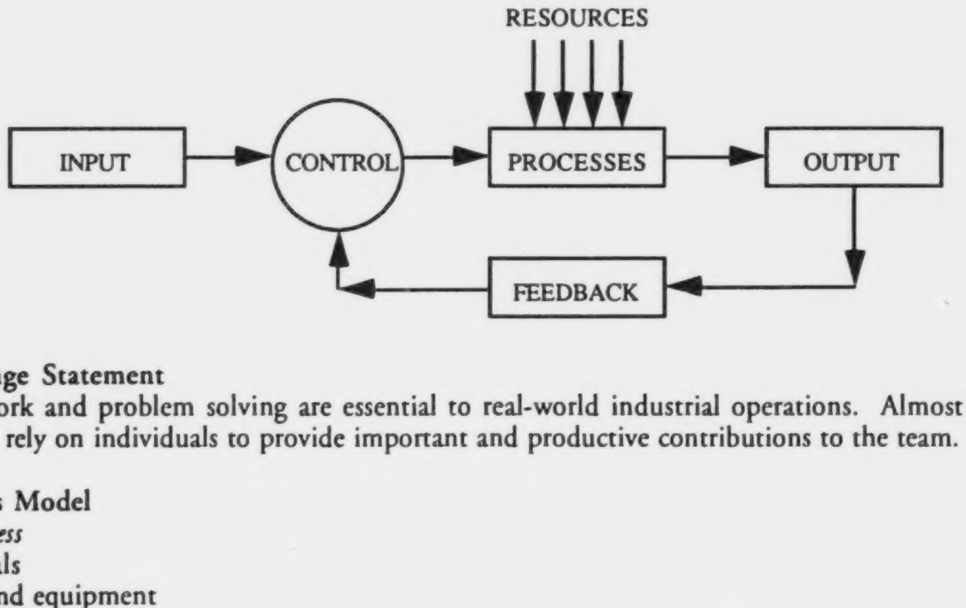
Evaluation
Instructor evaluation will be based on your participation in and completion of the activity and how well you met your instructor's standards for your model.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 31
(3 WEEKS)

BASIC SYSTEMS OF MANUFACTURING

Essential Elements: 1, 2, 13, 14
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview
This module focuses on the manufacturing aspects of production. It is a group activity organized around five topics: manufacturing inputs, resources, processes, outputs, and control. These five categories have been specifically tailored to manufacturing, and correlate very closely to the universal systems model for problem solving. Varying amounts of time can be spent on certain areas, according to the individual teacher's needs. Students will use the systems model to plan, organize, direct, and control personnel to design, engineer, produce, and market their product.



Challenge Statement
Teamwork and problem solving are essential to real-world industrial operations. Almost all industries rely on individuals to provide important and productive contributions to the team.

Systems Model
Resourcess
Materials
Tools and equipment
Background information
Team members

Processes
Design
Pattern making
Material handling
Cutting
Bonding

Shaping
Testing
Marketing

Applications
Large-group problem solving

Impact
Teamwork
Problem solving
Real-world industrial operations

Interfacing with Other Disciplines

Language Arts: Students will follow sequential directions to construct a product from design to marketing.
Mathematics: Students will add, subtract, divide, multiply, and work with measurement and fractions throughout this activity.
Social Studies: Students will become aware of the impact and implications of manufacturing through teamwork.

Critical Thinking Skills Reinforced

Students will design, fabricate, and market a product. They will apply math, language arts, and design skills throughout this activity. Evaluation will consist of quality-control assessments and discussion of possible redesign of the product and production system.

Teaching Tips

1. Review the entire activity and become familiar with the systems model as it relates to the manufacturing process.
2. Make sure students select a project with the appropriate degree of difficulty when setting the design parameters for the product. Students will often choose a product that is too difficult.
3. Allow enough time at the end of the module to make up for manufacturing bugs that occur during production. If the production runs smoothly and there is some time left, have the class test their redesigns after the evaluation.
4. The activity should include the manufacturing components of planning, organizing, directing, and controlling personnel to design, engineer, produce, and market the product.
5. This is a group activity that stresses the importance of teamwork. Discuss with the class the role of teamwork in the real world of work and how future technologies will need team players. Also encourage the use of individual student talents as in the use of machines, drafting, etc.
6. Provide students with the materials to create planning flowcharts and responsibility charts.

Instructional Strategy

This activity will provide opportunities for transfer of learning from various general education areas. Students would benefit by integrating concepts with other disciplines. Set clear standards for product design and production. Monitor the class continually for participation and safety. Allow time for students to redesign, if necessary, during the production process. Relate content to future business endeavors.

Equipment/Supplies

Depends on product selection

Evaluation Key

Students will be graded on participation and quality of the end product. If the product is not up to standards, allow students to improve their grades through evaluation and redesign.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity involves the use of various hand tools and machinery. Instructors may need to team special-needs students with non-special-needs students to complete this activity. It may be possible to request a support or resource teacher from the special education department to assist you during this activity.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 31

BASIC SYSTEMS OF MANUFACTURING

Activity Overview

In this activity you will be involved with the manufacturing aspects of production. It is a group activity organized around five topics: manufacturing inputs, resources, processes, outputs, and control. These five categories have been specifically tailored to manufacturing and relate very closely to the universal systems model for problem solving.

Challenge Statement

Teamwork is an important element of real-world industrial processes. It is important for you to develop a thorough understanding of teamwork by participating in a process in which every person is important to the results of the whole project. That is what industry is.

Objectives

- To identify the universal systems model as it relates to manufacturing technology
- To assess the importance of manufacturing technology to society, in providing useful articles for everyday life
- To delineate the necessary resources for manufacturing in our current society
- To analyze and demonstrate the various processes of manufacturing technology
- To evaluate the products and impacts of a manufacturing enterprise as to their quality and also their effect on society and environment
- To use mathematical and scientific principles in the solving of practical manufacturing problems within the laboratory setting
- To demonstrate problem-solving and analytical thinking skills in solutions to simple engineering problems within the context of laboratory activities

Vocabulary/Concepts Reinforced

- Manufacturing inputs
- Resources
- Processes
- Outputs
- Controls

Equipment/Supplies

- Depends on product selection

Introduction

As the production of the product begins and the first pieces leave the assembly line, they must be monitored to provide feedback to the control mechanism of the system. This feedback will provide vital information about any particular bugs or flaws that need to be adjusted in the process. The feedback element serves as the quality-control check to ensure that the product meets the standards or specifications established earlier.

Marketing is the final stage of the product development at the output end of the system. Marketing also serves to provide feedback to the system. Often the feedback causes changes in design to make the product more marketable. Marketing is one of the most vital elements in the process; without it there would be no need for production. Can you imagine how long General Motors could exist without marketing?

In order for the system to operate smoothly, all members of the class must cooperate and function as a team. Teamwork is just as important in industry and technology as it is in sports. Individual responsibilities, no matter how trivial they may seem, are important to the success of the enterprise. Large organizations such as NASA rely heavily on teamwork in their various programs.

View the systems model as a means to organize either a group such as your entire class or an individual to both analyze and solve problems in production technology.

Procedure

1. In this exercise, you will use the systems model to plan, organize, direct, and control personnel to design, engineer, produce, and market a product. Your teacher will provide guidelines for products that fit into the time frame and availability of supplies and equipment for this activity.
2. With your class divided into groups of four, each group should present an idea for a product that can be produced by the entire class. The entire class should select the product that best meets the needs for this project.
3. After selecting the product, each group should meet again to set the specifications. These specifications form the input element of the systems model, and should include the following (write them in the space provided).
    a. Primary material to be used (wood, metal, plastic, a combination, etc.)

    b. Secondary materials to be used (fasteners, decorative pieces, hardware, etc.)

    c. Size and shape of the product (the basic dimensions)

    d. Finishes to be used (paint, stain, varnish, oil finish, etc.)

    e. Production processes to be used (assembly line, custom production, etc.)

f. Methods of marketing the product (Do you plan to take orders? Would you produce a batch and hope to sell them? What alternatives are there?)

4. When each group has presented its set of specifications, the entire class should choose the best combination to establish one final set of specifications. This set should include all the possible components that will go into producing the product. The input element is complete when the specifications are clearly outlined.
5. At this point, one or two students from the class should be assigned to complete a technical drawing of the product.
6. While the drawing is being completed, the remaining class members should evaluate the resources available to produce the product. This evaluation should include the following criteria (write them in the space provided).
   a. What raw materials should be used?

   b. What tools and machines should be used?

   c. How will the class pay for the materials?

   d. What are the individual responsibilities of the class members? Each student should be included in some aspect of the production process. This activity should take advantage of the talents of individual class members. Some may have special skills that will help in either the production or marketing of the product. These talents should be listed and used as needed.

   e. Analyze the amount of time required for each phase of the production process. Establish a time chart to aid in the day-to-day operation of the process.

7. When the class has agreed to a single set of resources, the next step in the process is to organize the actual production of the product. Using the resources available to you, begin production of the product. Devise a production chart that lists each step in the process with the responsibilities of the individual students identified for each step.

Evaluation

Upon completion of the activity, the entire class should review the project. Each product should be checked for quality control. The class should discuss how well its enterprise worked using the systems model to help solve this production problem. What were the weaknesses? What were the strengths? What recommendations can your class make to the next group of students who are assigned this same activity?

SEPARATING AND FORMING POLYMERS

Essential Elements: 13, 14
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity is designed to allow students to study and use several manufacturing materials and processes in the production of a finished product. This activity will satisfy the required essential elements for Technology Systems by forming, separating, conditioning, assembling, and finishing a product.

Challenge Statement

To have a complete understanding of manufacturing, it is helpful to experience precision product fabrication by using the general processes of forming, separating, conditioning, assembling, and product finishing.

Systems Model

Resources
Background information
Materials
Plans and specifications

Processes
Pattern making
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Multitask project
Design specifications
Product fabrication

Impact
Basic industrial processes
Technology

Interfacing with Other Disciplines

Language Arts: Students will follow sequential directions to construct a product from written instructions.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement throughout this activity.
Science: Students will work with concepts of material manipulation.
Social Studies: Students will become aware of the impact and implications of quality workmanship in various manufacturing processes.

Critical Thinking Skills Reinforced

Students will apply and transfer written information to a hands-on activity. They will plan and organize materials to construct a manufactured product. Then they will analyze the product to identify various processes and extend that information to other products.

Teaching Tips

1. Read through the entire activity, and become familiar with each aspect of the project.
2. Consider this particular activity as an introduction to other dimensions of the essential elements. If the product described in this activity does not fit your needs, then use the activity format to produce something different.
3. Discuss with students the importance of plastics in our daily lives. Explain how their knowledge of manufacturing and production will help them to better understand the rapidly changing world of technology.
4. Demonstrate the activity to your students, and stress safety in the use of machines and hand tools.
5. The final discussion identifying various processes in everyday, industrially manufactured products will extend and expand the information to reinforce learning. This is the most important step in the entire activity.
6. If time permits, experiment with variations of the design. Alternatives might include the use of an engraver to carve a design into the plastic or perhaps combining the screen-printing process to add color and design to the product. Another alternative might be to combine different colors of plastic to create variations of the original design.

Instructional Strategy

Throughout this activity, provide opportunities for transfer of learning. Organize all supplies and equipment in advance to maximize time. Set clear expectations for quality of work. Monitor students closely for safety. Check for understanding throughout the activity, and reteach if necessary. Extend information in the evaluation process.

Equipment/Supplies

1. Drill press with bits
2. Electric sander
3. Strip heater
4. Scroll saw or band saw
5. Screwdriver
6. Layout tools and templates
7. Clamps
8. Center punch
9. Miter box or radial arm saw
10. Jack plane
11. Sanding block
12. Sandpaper
13. Safety glasses
14. Hardwood
15. Plastic
16. Finishing materials
17. Wood screws
18. Shop drawings
19. Plexiglas

Evaluation Key
Evaluation should be based on the students' successful completion of the project in addition to the follow-up worksheet.

Modifications for Handicapped, Disadvantaged, and LEP Students
This activity may require having students work independently with hand tools and various pieces of equipment. It may be necessary to arrange having an aid or resource person from the special education department help with this activity. Otherwise, you may want to use the buddy system to ensure that your special-needs students are able to participate in the project.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 32

SEPARATING AND FORMING POLYMERS

Activity Overview

This activity is designed to allow you to study and use several manufacturing materials and processes in the production of a finished product. You will use processes of forming, separating, conditioning, assembling, and finishing a product.

Challenge Statement

To have a complete understanding of manufacturing, it is helpful to experience precision product fabrication by using the general processes of forming, separating, conditioning, assembling, and product finishing.

Objectives

- To manufacture a polymer product within specified specifications and tolerances
- To identify and describe the processes and materials used to produce a selected product
- To identify and describe the critical design elements and processing principles included in the selection of a product

Vocabulary/Concepts Reinforced

- Separating
- Conditioning
- Forming
- Assembling
- Finishing
- Polymer

Equipment/Supplies

- Drill press with bits
- Electric sander
- Strip heater
- Scroll saw or band saw
- Screwdriver
- Layout tools and templates
- Clamps
- Center punch
- Miter box or radial arm saw
- Jack plane
- Sanding block
- Sandpaper
- Safety glasses
- Hardwood
- Plastic
- Finishing materials
- Wood screws
- Shop drawings
- Plexiglas

Introduction

This is a separation activity using a machine process (chip generation) with a reciprocating or rotary multiple-point cutting element moving into a stationary work piece.

Procedure

1. Read through the entire process before beginning this activity.
2. Study both the shop drawing and the materials list to ensure that you have the necessary supplies.
3. Using either the miter box or radial arm saw, cut a piece of hardwood material 7 inches long from a piece of the standard stock.
4. Locate the center, and center-punch the location of the screw pilot holes on the top surface of the hardwood base 2 inches from either end.
5. Using the drill press, drill two 1/16-inch pilot holes at these points on the hardwood base.
6. Using the jack plane, create a 1/4-inch chamfer on the top edge of the hardwood base. Complete this cut on all top edges, both sides and ends.
7. Abrade (sand) all edges and surfaces to the desired surface finish.
8. Using a template or layout tools, locate and mark the radius on the four outer corners of the Plexiglas, and locate the screw shank holes for connecting the plastic to the hardwood base.
9. Using a band saw or jigsaw, machine (cut) the desired shape out of the Plexiglas. Be sure to cut on the outside of your layout lines.
10. Using the drill press, drill two 1/8-inch holes through the Plexiglas for the no. 4 wood screws.
11. Abrade (sand) all edges to the desired surface finish.
12. Remove the protective covering from the Plexiglas sheet.
13. Using the template, locate and mark the bend points on the Plexiglas sheet.
14. Carefully place these points on the strip heater.
15. Bend the Plexiglas sheet to a 90-degree angle exactly at the bend points.
16. Cool the bend areas with a damp rag.
17. Apply an appropriate natural penetrating oil to the sanded hardwood base.
18. Assemble the bent Plexiglas and the hardwood base using the two no. 4 wood screws (5/8 inch).
19. When you complete the hands-on activity, answer the worksheet carefully, evaluating your product as you answer each question.
20. Discuss the different manufacturing processes used in the activity. Examine other industrially manufactured products to point out processes you used in your activity.

Evaluation

Instructor evaluation will be based on your participation in and completion of the activity along with the accuracy of your worksheet.

NATURAL AND SYNTHETIC POLYMER PRODUCT FOLLOW-UP WORKSHEET

NAME:______________________________ DATE:______________________

1. Identify and describe the type of separation process(es) and machine and material motions used during the crosscutting operations.

2. Identify and describe the type of separation process(es) and machine and material motions used during the drilling operations.

3. Identify and describe the type of separation process(es) and machine and material motions used during the production of the chamfer.

4. Identify and describe the type of separation process(es) and machine and material motions used during the abrading operations.

5. Identify and describe the type of separation process(es) and machine and material motions used during the manufacturing of the Plexiglas.

6. Identify and describe the forming and conditioning process(es) used to form and shape the synthetic polymer part of the product.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 33
(5 DAYS)

BUILDING A LAKE HOUSE

Essential Elements: 1, 2, 13, 17, 18
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity is designed as a small-group project in which students form a simulated construction company to build a house. The project uses construction management skills in design, management, and construction practices to construct a scale model.

Challenge Statement

It is important for students to understand the value and function of teamwork as it applies to problem-solving activities. These elements will become a vital component of their activities not only as industrial technology students, but also as future members of America's work force.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Design
Material handling
Cutting
Bonding
Shaping
Simulation

Applications
Small-group problem solving
Simulation activity

Impact
Simulation
Basic problem solving
Industry and technology

Interfacing with Other Disciplines

Language Arts: Students will follow sequential directions to design and construct a model of a home from given specifications.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement and an architect's scale. They will determine volume and area throughout this activity.

Social Studies Students will become aware of customer relations in business.

Critical Thinking Skills Reinforced

Students will apply the design loop to the activity. They will analyze specifications to design, organize, plan, and construct the lake house. Each student will be evaluated on his or her class presentation.

Teaching Tips

1. This is a small-group activity. Divide the class into groups of three or four students.
2. Review and discuss the basic organization of a construction company. Stress the importance of individual responsibility and teamwork.
3. Present the design problem clearly, using the "Owner's Design Specifications" handout. Give examples to illustrate the various aspects of design specifications.
4. Review the procedures for drawing to scale.
5. Demonstrate how to use foam-core board to create wall sections. Show students how to cut out the doors and windows. The gable ends should be assembled as part of the roof system so that the interior can be viewed when the roof is lifted.
6. Demonstrate the safe use of the X-acto knife and hot glue gun.
7. Make sure that all students are involved in the project. While one or two students are working on the floor plan, the other students can be working on the elevation or can begin gathering materials.
8. The instructor has multiple roles in this activity. First, you serve as the property owner and must approve or disapprove of the plans as they are presented to you. Second, you serve as the building inspector, and must monitor the construction of the houses to ensure that they meet the minimum standards you have established.

Instructional Strategy

Set the scene as property owner and contractor as realistically as possible to create interest in the project. Review any background information necessary (measuring, reading to scale, drawing to scale) to ensure success for all students. Demonstrate construction processes to students. Use this activity as a small-group, team-building project. Encourage the use of brainstorming to generate ideas. Use technical reference material as available. Evaluate students during their presentations of models and during discussion.

Equipment/Supplies

1. Foam-core board for wall panels and roof sections (*Note:* Houses should be built to 1/4" scale.)
2. 1/2" plywood (8 1/2" x 14" for the foundations)
3. 1/2" plywood (18" x 24" for the property area)
4. Hot glue gun and glue sticks
5. 11" x 15" drawing paper for house plan designing
6. Drawing boards and T-squares
7. Colored construction paper for siding and roofing material
8. Posterboard for roof sheathing and trim material
9. Assorted sandpaper for asphalt shingles, cut into strips
10. Graph paper for designing purposes

Evaluation Key

Instructor evaluation should be based on student participation in and completion of the activity. Student teams should be allowed to present their completed projects to the entire class for discussion.

Modifications for Handicapped, Disadvantaged, and LEP Students

If you have special-needs students in your class, arrange for them to be assigned to different teams. You may also want to have a resource person come in from the special education department to help with individual students as needed.

Support Materials

1. House plans
2. Construction and architecture textbooks
3. "Owner's Design Specifications" handout

OWNER'S DESIGN SPECIFICATIONS

1. Lot size: 72' wide x 96' long

2. House dimensions: 34' wide x 56' long

3. House configuration: three bedrooms, two bathrooms, one living area, one kitchen, one dining room

4. Doors:
   exterior: 3'0" x 6'8"
   interior: bedrooms 2'8" x 6'8"
   bathrooms: 2'0" x 6'8"
   closets: 6'0" x 6'8" (sliding closet doors)

5. Windows/sliding glass doors: open for design considerations
   Note: The owner likes the scenery and wants as much glass as possible.

6. Roof: 5:12 pitch with 2' overhang

7. The design should include a covered porch at the front of the house.

8. Siding: horizontal 1' x 10" lap and gap (construction paper)

9. Window and door trim: 1' x 4" rough-sawn cedar (posterboard)

10. Fascia: 1' x 6' rough-sawn cedar (posterboard)

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 33

BUILDING A LAKE HOUSE

Activity Overview

Students will work in small groups to design and build a scale model lake house. The group will simulate the activities of a construction company in designing, planning, and constructing the house.

Challenge Statement

As the owner of a construction company, you have the job of designing and building a scale model of a lake house, following your client's specifications.

Objectives

- To describe the basic design/construction sequences by which a construction company designs and constructs a house
- To gain experience in customer relations
- To gain experience designing and building a house to scale from specifications

Vocabulary/Concepts Reinforced

- Architect
- Engineer
- Contractor

Equipment/Supplies

- Foam-core board for wall panels and roof sections (*Note:* Houses should be built to 1/4" scale.)
- 1/2" plywood (8 1/2" x 14" for the foundation)
- 1/2" plywood (18" x 24" for the property area)
- Hot glue gun and glue sticks
- 11" by 15" drawing paper for house plan designing
- Drawing boards and T-squares
- Colored construction paper for siding and roofing material
- Posterboard for roof sheathing and trim material
- Assorted sandpaper for asphalt shingles, cut into strips
- Graph paper for designing purposes

Introduction

This is a simulation activity in which the class will be divided into groups. Each group is to be considered a construction company. The role of the teacher is that of a property owner who has a lake lot on which he or she wishes to build a vacation house. The teacher has developed a set of design specifications for the house.

Your group, acting as a general contractor, will design a house that meets the owner's specifications, present the design to him or her for approval, and build the house according to the plans and specifications.

Procedure

1. Divide your class into groups of three or four students. Remember that this is a group activity and will require the participation of each member of the group. Successful teamwork is one of the most important factors for actual construction companies.
2. Carefully study the design specifications issued by the owner of the project.
3. This is a simulation exercise. Your construction company is responsible for completing three primary objectives:
    a. Designing the house
    b. Managing the project
    c. Constructing the project
4. After your group has reviewed the specifications, use the graph paper provided by your instructor to begin designing the house. Use the 1/4" scale for both drawing and building the model. Each member of the group should complete a rough draft or preliminary design.
5. From these preliminary designs your group is to choose the one design that best represents the project that your group wants to present to the owner. This design may use design elements from each member.
6. Meet with the owner to discuss your proposed design. Make the necessary adjustments or changes to the design.
7. After your group has received permission from the owner to go ahead with the plan, draw a set of working plans that includes the following:
    a. Floor plan
    b. Front elevation
    c. Right- and left-side elevations
    d. Rear elevation

    Note: Scale 1/4" = 1'0"
8. When the plans have been completed, submit them again for the owner's approval. If they are accepted, go to the building inspector for a building permit.
9. After obtaining the buiding permit, begin building the house.
10. Lay out the wall lines on the foundation, and mark the locations of doors and windows.
11. Construct the wall panels. Cut out the doors and windows before installing the panels.
12. An alternate method at this stage is to cut out the drawn elevations and glue them directly to the wall panel sections.
13. Assemble and install the wall panels.
14. Finish the interior and exterior as needed.
15. Have the building inspector make a final building inspection.
16. Landscape and finish the building site.
17. Present the finished product to the owner and class.
18. Discuss each model.

Evaluation

You will be graded on how well your model meets the specifications of the owner.

TRANSPORTATION-RELATED CONSTRUCTION

Essential Elements:	1, 2, 12, 13, 15, 17, 18
TAAS Objectives:	Language Arts: RC 1–5; WC 5–7 Mathematics: C 1, 3, 4; O 1–4; PS 1–3

Activity Overview

This activity will introduce students to construction related to the transportation industry. Students will be developing a transportation system that can support a vehicle created from modular components.

Challenge Statement

Your students will have an opportunity to work in a large-group, problem-solving activity in which they use several elements of both transportation and construction to design and construct a complete transportation system.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Design loop
Material handling
Cutting
Bonding
Shaping
Assembly
Finishing
Testing

Applications
Small-group, problem-solving activity
Technical systems

Impact
Teamwork and problem solving
Real-world industrial operations

Interfacing with Other Disciplines

Language Arts: Students will follow sequential directions to construct a model of an ATS. They will give a verbal description and demonstration of their model.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement throughout this activity.

Science: Students will work with concepts of transportation and construction systems.

Social Studies: Students will become aware of the impact and implications of mass transit.

Critical Thinking Skills Reinforced

Students will apply learned and observed knowledge of transportation to planning, designing, and constructing a model transportation system. They will expand their application through evaluating models from all groups. In addition, they will have a broad base of ATS possibilities to compare and consider.

Teaching Tips

1. This is a fun activity. Students get really interested in creating vehicles and transportation systems. Before you start the activity, you will need to decide, based on the equipment you have (e.g., Lego Techtronics, Fisher Technic, Multibotics), the width of the track on which the vehicle must operate. One dimension that could be used is 5/8 inch. Groups will need to know this dimension to work together to trade information. Decide how the track will be supported. This will also affect how the vehicle is designed.
2. Set a size limit to the track. Your lab may have limited space or materials. The vehicle will need to be powered somehow. Batteries or solar cells will work best; there is no need to have a "hot" power line from which students could receive an electrical shock.
3. This activity provides opportunities to discuss social and environmental issues. Students should gain an understanding of the responsibility involved in using the transportation system.

Instructional Strategy

This activity provides an opportunity for students to transfer transportation knowledge and imagination to a real-life transportation exercise. Present new terms clearly for accurate communication about the project. Set realistic expectations and specifications for the student model. Organize materials and supplies in advance to maximize time. Evaluate the students according to your prior specifications. Discuss each model with its benefits and limitations.

Equipment/Supplies

1. Material for rail system: plywood, metal, plastic, etc.
2. Modular components kit (Lego Techtronics, Fisher Technic, or Multibotics)
3. Power source (batteries, solar cells, etc.)
4. A computer interface to control the system (optional)

Evaluation Key

Give each student a daily grade based on participation in the work of the group. Give a group grade for the presentation and completed transportation system. Answers to handout questions are as follows:

1. Define the following:
   a. *Propulsion:* Propulsion systems are methods of moving or propelling vehicles; the three major types are gas turbine engine, diesel electric locomotives, and nuclear energy.

   b. *Suspension:* Suspension systems support the vehicle's weight while allowing motion to happen.
   c. *Guidance:* Guidance systems provide the necessary information to move a vehicle on a prescribed path.
   d. *Control:* Control systems provide traffic control and vehicular control. Traffic control regulates the flow of traffic. Vehicular control allows one to manipulate the vehicle.
   e. *Structure:* Two structure types related to transportation exist: fixed and moving. Fixed structures include roads, bridges, tunnels, terminals, airports, and spacecraft launch pads. Moving structures are the mobile units or vehicles that transport material goods or people.
   f. *Transportation:* Transportation is the moving of people or goods from one point to another via an organized system.
   g. *Automated transit system:* An ATS is an enclosed carlike vehicle that moves about on its own track and can perform the same functions as a car on a road.

2. List four of the six technical support systems in transportation:
   a. Propulsion
   b. Suspension
   c. Guidance
   d. Control
   (Structure)
   (Support)
3. List three of the five specific factors that must be considered when building a highway:
   a. Capacity of the road
   b. Legal constraints
   c. Environmental constraints
   (Monetary constraints)
   (Projected development of the area)
4. List the two major types of ATS:
   a. Shuttle transit system
   b. Network transit system

Support Materials

1. DeVore, Paul W., ed. *Introduction to Transportation.* Worcester, Mass.: Davis Publications, 1983.
2. Films about ATS are available for viewing from Bay Area Rapid Transit District, San Francisco, CA; METRO System, Westinghouse Electric Corporation; AirTrans, Dallas-Ft. Worth Airport, Dallas, TX; M-PRT, West Virginia University, Morgantown, WV.
3. Nontechnical reports are available on the system assessments of AirTrans and M-PRT from the Department of Transportation, Urban Mass Transportation Administration, Washington, D.C.
4. You may also want to write to the Office of Technology Assessment, Washington, D.C., for literature on automated transit systems.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Teaming special-needs students with non-special-needs students is one method of ensuring that they participate in the activity. Suggest that your students incorporate the needs of special populations into their designs.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 34

TRANSPORTATION-RELATED CONSTRUCTION

Activity Overview
You will develop a transportation system, from modular components, that can support a vehicle.

Challenge Statement
Transportation systems will become one of the major issues for future populations. Mass transportation is an issue that must be addressed now for environmental concerns.

Objectives
- To list the six major systems involved in transportation
- To define *propulsion, suspension, guidance, control, structure, support,* and *automated transit system* (ATS) as they relate to transportation
- To work safely in the lab

Vocabulary/Concepts Reinforced
- Propulsion
- Suspension
- Guidance
- Control
- Structure
- Transportation
- Automated transit system

Equipment/Supplies
- Material for rail system: plywood, metal, plastic, etc.
- Modular components kit (Lego Techtronics, Fisher Technic, or Multibotics)
- Power source (batteries, solar cells, etc.)
- A computer interface to control the system (optional)

Introduction
The transportation industry is important to the economy of our country. Personal automobile transportation is important to us as individuals for convenience (going where we want, when we want), necessity (going to work), socialization (going on dates, going to the mall, cruising), entertainment (drag races, NASCAR races, the Indy and Daytona 500), security (police, fire, ambulance), food source (pizza delivery), and pleasure (moving down the highway in a Porsche or Corvette convertible). This unit will investigate how construction is essential to the transportation industry. Transportation is the moving of people or goods from one point to another via an organized system.

Note: This introductory material is based on *Introduction to Transportation,* edited by Paul W. DeVore (Worcester, Mass.: Davis Publications, 1983). Page numbers are cited in parentheses.

Six technical systems are common to all types of transportation systems (p. 31). These are propulsion, suspension, guidance, control, structure, and support. Propulsion systems propel vehicles. Three major types of vehicular propulsion systems exist: gas turbine engine, diesel electric locomotives, and nuclear energy. Suspension systems support the vehicles' weight while allowing motion to happen. Three types of suspension systems work well: mechanical, fluid, and magnetic. Guidance, as related to transportation, concerns the relationship between the human operator and the machine. Guidance systems provide the necessary information to move a vehicle on a prescribed path.

Control systems provide traffic control and vehicular control. Traffic control regulates the flow of traffic. Vehicular control allows one to manipulate the vehicle. Two structure types related to transportation exist: fixed and moving. Fixed structures "include roads, bridges, tunnels, terminals, airports, and spacecraft launch pads" (p. 42). Moving structures are "the mobile units or vehicles used to carry out the prescribed activity function either in the transporting of material goods or people" (p. 42). Support systems include the terminals, harbors, spacecraft launch sites, and facilities used for maintenance, servicing, and manufacturing of structures.

In addition to the six technical systems, several specific factors are involved in planning highway construction: capacity of proposed road, legal constraints, environmental constraints, monetary constraints, and projected development and growth of the area where the road will be located. Lots of research must take place before decisions can be made about building a road: sampling studies of the origin and destination of the road, counts of the traffic volume, estimates of traffic to be generated, and models of potential traffic flow.

Three other concerns are structure, the pavement, and drainage. Structure is an important factor in terms of what exists underneath the actual road and whether the road can be supported. This is a concern because some carriers (e.g., large trucks) tend to carry more weight than limits allow. Continual use of the roads in this manner destroys the roads. The pavement itself is important. Two types of pavement exist: rigid and flexible. The rigid system is based on concrete slabs with enough "strength and stiffness to spread the loads over a great area so that the underlying soil can sustain them" (pp. 126–127). In a flexible system, the material underneath the surface of the road is prepared so that it can support the load placed on the surface layer, which is just stiff enough to spread the load. Once all of the data are gathered, road designs are created for the safest flow of traffic. A site is then selected and surveyed, and construction can begin.

The current highway system is heavily used by individuals, usually one person to a vehicle. Environmental concerns have caused a number of people to look for alternative solutions. The environment is polluted by exhaust, nonrenewable energy sources are used up, and smog is caused by congested urban roadways. Several alternatives exist: buses, trains, planes, and automated transit systems (ATS). We will study automated transit systems in more detail.

An automated transit system (ATS) can be defined as "a class of transportation systems which operate on their own right of way with longitudinal and lateral control of the vehicles performed automatically in a driverless fashion. Lane changing, merging, and demerging at intersections are also achieved automatically" (p. 201). In other words, an enclosed carlike vehicle moves about on its own track and can perform the same functions as a car on a road. The advantages and disadvantages of an ATS can be compared with those of a conventional transit system (like the Dallas or Houston city bus system). The operating cost comparison favors the ATS based on service per unit. As there are no drivers, labor costs are low. Even though an ATS costs more to create and start up, it will have lower operating and maintenance costs. Automated systems have high safety levels compared with conventional systems. They provide comfortable, convenient, reliable, quick, and frequent service. They are efficient in their use of energy compared with conventional transit systems. They also help reduce pollution because they operate with electricity, not fossil fuels. Use of the system by passengers also reduces pollution, as large numbers of people would be riding the ATS rather than driving their own vehicles.

There are two major types of ATS: shuttle transit systems and network transit systems. The shuttle system has vehicles that move back and forth in one direction or on a circular path. These are used mostly in airports, amusement parks, hospitals, or shopping centers. The network system is very complex and is used to collect and distribute passengers.

Control of an ATS is a process that "regulates the movements of its vehicle in the most efficient and safe manner" (p. 203). In developing an ATS, the same considerations used in constructing highways must be considered: capacity of the system, legal constraints, environmental concerns, monetary constraints, and projected development of the area served. Usually areas served by an ATS are highly developed urban areas or airports, so the development concerns are different from those related to new roadways. Money is usually one of the biggest issues; who is going to pay for the system, what will happen if people don't use the system, and what will happen to drivers employed by the existing conventional system? These are highly charged, emotional issues to the individuals involved.

Several automated transit systems exist already. Some that you may be familiar with are the monorails at DisneyWorld and Disneyland or the passenger transits at the Dallas-Ft. Worth (DFW) and Houston airports. Other major systems that are successful include the Bay Area Rapid Transit system (BART) in the San Francisco area, the PATCO Lindenwald Line in Philadelphia, and the METRO in Washington, D.C. The BART system is over 60 miles long, and parts of it go underneath the bay spanned by the Golden Gate Bridge. At DFW, the system is capable of moving 9,000 people per hour. Some vehicles are used to move luggage and mail.

In this activity, we will be constructing our own ATS, including a guidance system and vehicles.

Procedure

1. Complete handout.
2. Work in groups; groups should be paired so that one group is creating the transportation system while the other group is creating the vehicle to operate on the transportation system.
3. Request demonstrations of any equipment that you may not have used before.
4. Design and build your transportation system or vehicle. Work together to iron out any bugs in your transportation system and vehicle.
5. Present your work to the class.

Evaluation

You will receive a daily grade based on your participation in the work of the group. Your group will receive a grade for its presentation and completed transportation system.

TRANSPORTATION-RELATED CONSTRUCTION EVALUATION

1. Define the following:
   a. Propulsion: ____________________
   ____
   b. Suspension: ____________________
   ____
   c. Guidance: ____________________
   ____
   d. Control: ____________________
   ____
   e. Structure: ____________________
   ____
   f. Transportation: ____________________
   ____
   g. Automated transit system: ____________________
   ____
2. List four of the six technical support systems in transportation:
   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
3. List three of the five specific factors that must be considered when building a highway:
   a. ____________________
   b. ____________________
   c. ____________________

4. List the two major types of ATS:

a. ____

b. ____

(1–2 WEEKS)

MASS PRODUCTION

Essential Elements: 1, 2, 12–14, 16
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity will engage students in the mass production of a product. They will learn about the inputs, processes, and outputs of manufacturing. The focus of the product is a community service activity. Other products may be substituted.

Challenge Statement

Your students will participate in a large-group, problem-solving activity in which they mass-produce a product for a community public-service project.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Designing
Pattern making
Cutting
Bonding
Shaping
Testing
Finishing
Product distribution

Applications
Large-group, problem-solving activity
Several technology systems

Impact
Teamwork
Problem solving
Real-world industrial operations

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Interfacing with Other Disciplines

Language Arts: Students will determine a community need, then follow sequential directions to construct a product.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement throughout this activity.

Social Studies: Students will become aware of impacts and implications of meeting community needs through mass production.

Critical Thinking Skills Reinforced

Analysis and synthesis are used by the group in designing and fabricating the mass-produced product. Students must work as a group to determine a community need, then design a product to meet that need. The hands-on, mass-production activity will require students to apply and expand their ideas to a visible product. The class will evaluate the end product to determine if the needs of the community have been met through its production.

Teaching Tips

1. Keep the projects simple. Students have great ideas, but they may need limits to keep the project from becoming overwhelming for the time frame. The product is not the main focus of the activity. Meeting the needs of the community through imagination and industry is the intent.
2. You can create a corporate structure and set up a company with officers to meet all technology education essential elements and integrate other subject areas into the activity.

Instructional Strategy

Introduce manufacturing, and brainstorm a community problem to create interest in the activity. Encourage product ideas and designs to solve the problem. Have the class pick a solution, and start outlining the necessary steps in the production run. Monitor the production line, paying particular attention to safety. Encourage reluctant students to get involved through praise and teamwork. Introduce quality control, and have your students redesign to correct any errors that are found. Package the products, and prepare for distribution. Expand the evaluation with a discussion of existing products and the needs they meet in society.

Equipment/Supplies

1. Tools and machines for wood, metal, plastic, or a combination
2. Jigs and/or fixtures (as needed for production run)

Evaluation Key

Worksheet answers:

1. List three of the seven resources of technology, and describe one specific aspect about each of those three resources as related to your manufacturing enterprise:
   Capital, energy, knowledge, machines, materials, people, tools
   Relation to our manufacturing enterprise: (answers will vary)
2. Define the following terms:
   Community service: meeting a need of other groups or individuals within the community
   Capital: the monetary resources necessary to finance a manufacturing enterprise
   Energy: provided by the utility company to run machines or provided by people to do work
   Knowledge: used by managers to determine what products are needed and how many will probably be needed (Supervisors use their knowledge of workers and machines to keep both working at the optimum level.)

Machines: necessary to do work that is too difficult for people to do (Machines can also do work more accurately than people in a situation where all of the products need to be built exactly alike.)

Materials: the wood, metal, plastic, ceramic, or other natural resources needed to manufacture an item

People: the most important part of the manufacturing enterprise (Although there are a few factories that operate mostly by robots, people are still needed to fix the robots and determine what products to make)

Tools: needed by people and machines to do work on the manufacturing line

Manufacturing: using the resources of technology to turn raw materials into usable products

Support Materials

1. *Rolling On: A History of the Tire.* 14-minute film about design and manufacturing. Available from Modern Talking Picture Service, 5000 Park Street North, St. Petersburg, FL 33709-9989.
2. Eye Protection Information Packet available from Texas Society to Prevent Blindness, 3211 West Dallas, Houston, TX 77019.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified as the teacher deems necessary to take into account the needs of special students. Teaming special-needs students with non-special-needs students is a good method to ensure participation in the activity. Use personnel within the school who can help support these students.

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TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 35

MASS PRODUCTION

Activity Overview
You will be involved in the mass production of a product. You will learn about the inputs, processes, and outputs of manufacturing. The focus of the product is a community-service project.

Challenge Statement
What are the needs of your community that are not being met? Do you know what they are? Can you solve them?

Objectives
- To identify a need of another group of people
- To design a product to fit the need of that group of people
- To work safely in the lab

Vocabulary/Concepts Reinforced
- Community service
- Inputs
- Processes
- Outputs
- Feedback
- Capital
- Energy
- Knowledge
- Machines
- Materials
- People
- Tools
- Manufacturing

Equipment/Supplies
- Tools and machines for wood, metal, plastic, or a combination
- Jigs and/or fixtures (as needed for production run)

Introduction
Manufacturing is a process that helps make possible the high living standard we have in our country. Manufacturing uses the resources of technology to turn raw materials into usable products. Products that were made one at a time were very expensive. The use of interchangeable parts was a major step in the manufacturing process. Henry Ford was the first automobile maker to heavily use the mass-production model, whereby one worker does the same job all day. Recently another type of manufacturing model has gained notice—teamwork. With the Swedish model of teamwork, a team builds an entire engine and tests it for quality. With

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the Japanese method of teamwork, team members also work together, but not always on the same part of a vehicle.

What are the resources of technology? Capital, energy, knowledge, machines, materials, people, and tools. What are the specific resources of manufacturing? Capital is needed; banks usually loan money to provide the startup capital for a manufacturing enterprise. Energy is provided by the utility company and by people working on the manufacturing enterprise. Knowledge is used by managers to determine what products are needed in what quantity. Supervisors use their knowledge of workers and machines to keep both working at the optimum level. Machines are necessary to do work that is too difficult for people. Machines can also do work more accurately than people, when all of the products to be built are exactly alike. The materials used to manufacture an item are wood, metal, plastic, ceramic, and other natural resources.

People are the most important part of the manufacturing enterprise. Although there are a few factories that operate mostly by robots, people are still needed to repair the robots and determine what products to make. Tools are also needed by people and machines to do work on the manufacturing line.

In this project you will work as a group to identify a community need and design a product to meet that need. A manufacturing production line should then be set up for production to take place. An example might be taking responsibility for a Christmas tree for a local "Symphony of Trees" festival by producing the ornaments and other decorations. School emblems or ornaments with the school mascot might be another idea. The "Toys for Tots" drive at Christmas is always looking for toy donations. Look around the community. There are a lot of people who need help.

Procedure

1. Identify a community problem or need.
2. Brainstorm ideas to solve the problem or meet the need.
3. Design a product to meet the need.
4. Set up a production run, and mass-produce a quantity of the product.
5. Evaluate your product. Does it meet the need you identified at the beginning of the activity?
6. Follow the class product evaluation with a discussion of existing products and the needs they meet in society.
7. Complete the worksheet and turn it in to your instructor.

Evaluation

You will be evaluated on your participation in the activity and completion of the worksheet.

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MASS PRODUCTION WORKSHEET

1. List three of the seven resources of technology, and describe one specific aspect about each of those three resources as related to your manufacturing enterprise:

a. ______________________________

b. ______________________________

c. ______________________________

Relation to your manufacturing enterprise (#a):

____

____

____

Relation to your manufacturing enterprise (#b):

____

____

____

Relation to your manufacturing enterprise (#c):

____

____

____

2. Define the following terms:

Community service: ______________________________

____

Capital: ______________________________

____

Energy: ______________________________

____

Knowledge: ______________________________

____

Machines: ______________________________

____

Materials: ______________________________

____

People: ______________________________

____

Tools: ______________________________

____

Manufacturing: ______________________________

____

BATCH MANUFACTURING

Essential Elements: 1, 2, 6, 13–16
TAAS Objectives: Language Arts: RC 1–6; WC 1–4
Mathematics: C 1, 3, 4; O 1–4; PS 1–4

Activity Overview

This activity will introduce students to the concepts and skills related to batch manufacturing. In this case, uniqueness is valued, and there is little concern that products be exact duplicates of each other. One part of the activity will be to produce fiberglass skateboards. Each student will be allowed to design the top layer of fiberglass so that each skateboard is different.

Challenge Statement

Students should develop a sense of responsibility through group problem-solving activities. This activity helps to reinforce the need for individual responsibility and cooperation.

Systems Model

Resources
Materials
Tools and equipment
Background information
Team members

Processes
Design loop
Pattern making
Material handling
Cutting
Bonding
Shaping
Testing
Finishing

Applications
Large-group, problem-solving activity
Several technology systems

Impact
Teamwork
Problem solving in real-world industrial operations

Interfacing with Other Disciplines

Language Arts: Students will follow sequential steps to construct a product and complete written forms to determine the sequence. They will complete a written evaluation.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement and measuring tools throughout this activity.

Social Studies: Students will become aware of the impact and implications of meeting community needs through production. They will be involved in completing a task through group cooperation and participation.

Critical Thinking Skills Reinforced

The class will use teamwork to choose, design, and produce a product for batch manufacturing. Students will apply the design loop to the planning and design of the group product. They will apply their knowledge about design and production processes to prepare an end product through a hands-on activity. They will evaluate and modify their first product and make revisions if necessary. They will complete a written evaluation sheet to demonstrate their understanding of the information.

Teaching Tips

1. Have the students set the production line up in such a fashion that there is little room for error.
2. Remind the students of safety rules and continually check for safe operations.
3. Check for quality control after the first product is produced. Have the students make revisions if necessary.

Instructional Strategy

Introduce manufacturing and batch manufacturing processes by giving examples of common, everyday products your students use that are batch-manufactured. Encourage all students to participate in brainstorming product ideas and designs. Clarify the importance of accurately planning the steps of production for a smooth run. Supervise the production run, keeping a close watch over safety. Have students check their products using quality-control measures. Evaluate the products through class input. Check the evaluation form carefully for understanding.

Equipment/Supplies

1. Operation Sheet
2. Flow Process Chart
3. Because you are setting the limits for time and materials for this activity, use only what is readily available to your particular lab setup.

Evaluation Key

Manufacturing Quick Check answers:

1. Define batch manufacturing:
   Intermittent or batch manufacturing is used to produce items in small batches, such as cookies in a bakery. This type of production allows for some customization.
2. Explain the difference between batch, custom, and continuous manufacturing:
   Custom manufacturing allows for singular items to be made at one time, while continuous manufacturing creates large numbers of one item. Batch manufacturing is in between the two; many products are made, but not as many as in continuous manufacturing, and some customization is possible.
3. Answers will vary.
4. Answers will vary.

Support Materials

Machine Tool Careers: Meeting Tomorrow's Challenge. 28-min. film. Available from Modern Talking Picture Service, 5000 Park Street North, St. Petersburg, FL 33709-9989. Free rental.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Teaming special-needs students with non-special-needs students is one method of ensuring that they can participate in the activity. Use resource teachers as they are available to help special-needs students in your lab areas.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 36

BATCH MANUFACTURING

Activity Overview

This activity will engage you in the use of batch manufacturing concepts. You will be encouraged to create and incorporate individual design work into the process.

Challenge Statement

Developing an understanding of batch manufacturing will help you understand and appreciate the products you use and may one day design.

Objectives

- To define batch manufacturing
- To explain the difference between batch, custom, and continuous manufacturing
- To work safely in the lab

Vocabulary/Concepts Reinforced

- Batch manufacturing
- Continuous manufacturing
- Custom manufacturing

Equipment/Supplies

- Operation Sheet
- Flow Process Chart
- Your teacher will identify available materials and equipment.

Introduction

Manufacturing is an important part of the American way of life. Without manufacturing, many of the goods we are accustomed to would not be available. Most of the goods produced fall into one of three categories: custom manufacturing, intermittent or batch manufacturing, and continuous manufacturing or mass production.

Custom manufacturing can range from making a custom dress to manufacturing a jumbo jet. Intermittent or batch manufacturing is used to produce items in small batches, such as cookies in a bakery. This type of production allows for some customization. Continuous manufacturing is used when large numbers of parts or items are needed. Many goods made this way are produced on a production line, such as cars, household appliances, and bicycles.

Custom manufacturing, then, allows for singular items to be made at one time, while continuous manufacturing creates large numbers of one item. Batch manufacturing is in between the two; many products are made, but not as many as continuous manufacturing, and some customization is possible.

Procedure

1. The class will brainstorm ideas for a product that you will produce in a limited quantity. Your instructor will set limits of the amount of time you have to work, the materials available, and the number of products to be produced.
2. Your instructor will set up small groups to design the product that the class has chosen. Use sketches to draw your ideas. Choose the best one to present to the class.
3. Each group will present one idea to the class. As a class, vote on the best design for your batch production project.
4. Go back to your original groups and complete the Operation Sheet and the Flow Process Chart. Your teacher will explain how to do this.
5. Compare your chart with your classmates' in a group discussion led by your teacher. Now make one Operation Sheet and one Flow Process Chart that the entire class will follow on the production line.
6. Identify all jobs necessary to produce your product according to the charts. Your instructor will assign jobs.
7. Begin production being aware of safety and quality control.
8. Evaluate your product and complete the questions on the Manufacturing Quick Check.

Evaluation

You will be evaluated on your participation in the activity and completion of the Manufacturing Quick Check.

OPERATION SHEET

Job Description				
Step No.	Description of Operation	Machine	Tools and Equipment	Materials

FLOW PROCESS CHART

Name ______________________________

Date ________________ Score __________

PRODUCT NAME	FLOW BEGINS	FLOW ENDS	DATE
PREPARED BY: SECTION:		APPROVED BY:	
PROCESS SYMBOLS AND NO. USED	○ OPERATIONS ________ □ INSPECTIONS ________ ⇦ TRANSPORTATIONS ________ D DELAYS ________ ▽ STORAGES ________		

Task No.	Process Symbols	Description of Task	Machine Required	Tooling Required
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
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	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			

MANUFACTURING QUICK CHECK

NAME ____________________

1. Define *batch manufacturing* for 10 points. ____

____

____

2. Explain the differences between batch, custom, and continuous manufacturing for 10 points.

____

____

____

____

3. List 10 items that are best manufactured through batch production for 2 points each.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

4. List 10 items that would best be produced through continuous production for 2 points each.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

INTRODUCTION TO FUTURING—MANUFACTURING SYSTEMS

Essential Elements: 1, 2, 4, 6, 16, 19
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1, 3

Activity Overview

This activity is intended to provide students with a continuation of the previous activity in futuring. In this activity, however, students will be working in small groups, further exploring the concept of futuring by looking at manufacturing technologies of the future. Emphasis will be placed on researching emerging technologies, new management systems, new materials, new methods for manufacturing, new processes for manufacturing, and new types of jobs for workers.

Challenge Statement

Creative thinking, innovation, imagination, and forecasting are important elements to explore in technology education. Students need to develop basic skills in these areas to more fully appreciate their role as participants in a high technology world.

Systems Model

Resources
Materials
Background information
Team members

Processes
Design loop
Material handling
Cutting
Bonding
Shaping

Application
Small-group activity
Creative thinking

Impact
Teamwork
Futuring
Technical education

Interfacing with Other Disciplines

Language Arts: Students will record ideas in a visual form, then make an oral presentation.
Mathematics: Students will use math skills in creating a visual presentation.

Social Studies: Students will discuss the impacts and implications to society of a fast-paced, technical world.

Critical Thinking Skills Reinforced

Students will apply their present knowledge of manufacturing systems to future trends to create visual materials demonstrating their ideas. Class members will review, consider, and evaluate each presentation for originality. The students will discuss each idea and consider its validity. They will discuss other past ideas and inventions that were not considered valid at the time.

Teaching Tips

1. Adjust the time frame to meet the needs of your students.
2. Encourage creative thinking by your students. Discuss past ideas and inventions that were not considered valid at the time of invention.
3. Discuss the importance of futuring with your students.
4. Create a display bulletin board which will help illustrate some of the topics created by students. Some of your student's creations should be displayed outside the lab, where other students and teachers can see what activities your students are involved in.
5. Gather as many different resources as possible, e.g., issues of *Popular Science, Popular Mechanics, TIES* magazine, and other associated publications.
6. Arrange for a guest speaker to talk to your class about future trends in manufacturing.
7. Record appropriate segments of the Discovery Channel's program "Beyond 2000" that relate to future manufacturing concepts, if available.
8. Ask your school librarian, in advance, for suggested books and videos on the subject.
9. As a follow-up, discuss the importance of teamwork.

Instructional Strategy

Use current materials from magazines and videos to present the topic to create interest and stimulate the imagination. Monitor each group for participation and understanding. Provide a variety of materials to encourage a number of innovative ideas in presentation methods. Give positive feedback on all ideas. Use the evaluation to expand and extend ideas and information.

Equipment/Supplies

Provide a variety of materials that your students might use to help them illustrate or demonstrate their future manufacturing designs.

Evaluation Key

Teacher evaluation should be based on student participation in and completion of the activity. You will set the standards for student presentations.

Support Materials

1. Current events materials
2. School librarian

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students as needed.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 37

INTRODUCTION TO FUTURING—MANUFACTURING SYSTEMS

Activity Overview
This activity is the second in a series relating to futuring. In this activity, students will work in small groups to explore futuring and its association with manufacturing systems.

Challenge Statement
Creative thinking, innovation, imagination, and forecasting are important elements for technology education to explore. You can develop basic skills in these areas to more fully appreciate your role as participants in a highly technical world.

Objectives
- To discuss and describe some of the future trends in manufacturing technology
- To develop a futuristic view of a manufacturing process or material
- To participate in a small-group activity to develop a presentation of a futuristic view of a manufacturing process or material

Vocabulary/Concepts Reinforced
- Bioengineering
- Engineered materials
- Superconductors

Equipment/Supplies
Materials needed for this activity will vary according to the type of device each team will design. Teachers will provide as many varied materials as possible as well as access to an assortment of machines and equipment.

Introduction
Manufacturing technology is the backbone of our country; its future holds some rather important implications for us all. There are several emerging technologies that should be analyzed in terms of how they may affect future technological development. One area of change will likely be in management and organization of manufacturing operations. The management-worker connection will most likely change dramatically. Manufacturing materials will also change significantly as newly engineered materials are developed. Manufacturing methods such as robotics and micro manufacturing will also evolve into highly sophisticated and high-quality processes.

The knowledge base that drives manufacturing technology is an ever-changing process. Scientists and engineers have been able to create new technologies in extremely short time frames. Where it once took several years to develop a technological theory, it may now only take a matter of months. Some of the emerging manufacturing technologies include engineered materials, biotechnologies, and superconductivity. These developments are just a few of the theories that have evolved into real working technologies.

In the area of manufacturing materials there have been several developments in what are termed engineered materials. Ceramics, metallics, polymerics, and composites are forms of engineered materials. Ceramic technology has become one of the most important of these engineered materials. Ceramic materials are now being used for internal engine parts, computer circuitry, and optical cables. Because they are made from silica, sand, and oxygen, the raw materials are abundant throughout the world. Ceramic materials also combine well with metallic alloys for use in microelectric circuits. They are also resistant to high heat as is evident in the use of ceramic tiles on the outside surface of the space shuttle. Imagine an automobile engine made entirely of ceramic parts that requires no coolant. This is exactly the type of development that engineered materials are capable of achieving.

Another remarkable achievement that will prove to have important implications for manufacturing is the development of superconductors. Superconductors are materials that will conduct electricity with no resistance. Normally, when electricity flows through a circuit it encounters resistance, which results in loss of energy and production of heat. In superconductors there is no resistance, so there is no loss of energy and no heat. This technology is now being used to test magnetic levitation trains that will be able to travel at speeds of up to 300 miles per hour over a magnetic field.

One of the most dramatic areas of technological development is in what are termed biotechnologies. Biotechnologies include genetic engineering and genetically produced chemicals. These engineered chemicals are being used in the manufacture of medicines, growth hormones, insulin, anti-blood-clotting agents, and others. The genetic engineering of organisms is already in use in agriculture to produce disease-resistant plants. Experiments are also being conducted on animals to produce stock that will grow faster and be leaner and larger. There are also experiments being conducted on human genes to produce engineered organisms to possibly help cure fatal diseases, such as cancer and AIDS.

Procedure

1. You will be asked to work in small groups to facilitate this activity.
2. Your teacher will ask each group to select an area of manufacturing and create a futuristic view of what that technology will be like in one hundred years. Consider the changes that computers, robots, and space technology will bring.
3. Each group is to meet for a designated period of time to brainstorm ideas, create drawings to illustrate their ideas, and make a formal presentation to the class using some type of visual presentation.
4. The visual presentation can be a model, a posterboard-sized drawing, a play, or any combination of these or other ideas you have. Clear your plans with your teacher before you begin.

Evaluation

You will be graded on your participation and the quality of the presentation and presentation materials.

INTRODUCTION TO FUTURING—CONSTRUCTION SYSTEMS

Essential Elements: 1, 2, (6), 15, 18
TAAS Objectives: Language Arts: RC 1–6
Mathematics: C 1–3; O 1–4; PS 1–3

Activity Overview
This activity is intended to provide students with a continuation of the previous activities in futuring. In this activity, students will be working in groups to further explore the concept of futuring by looking at the construction technologies of the future. Emphasis will be placed on new materials and methods for construction.

Challenge Statement
Creative thinking, innovation, imagination, and forecasting are important elements for technology education to explore. Students should develop basic skills in these areas to more fully appreciate their role as students in a high-technology world.

Systems Model
Resources
Materials
Tools and equipment
Background information
Team members

Processes
Design loop
Pattern making
Material handling
Cutting
Bonding
Shaping
Testing

Applications
Small-group activity
Futuring
Technical problems

Impact
Teamwork
Creative thinking
Technology

Interfacing with Other Disciplines

Language Arts: Students will record ideas in a visual form, then make an oral presentation.

Mathematics: Students will use math skills in creating a visual presentation.

Social Studies: Students will discuss the impacts and implications of a fast-paced, technical world on society. They will consider the impact of changing basic living environments.

Critical Thinking Skills Reinforced

Students will apply their present knowledge of construction systems to future trends to create drawings and models demonstrating their ideas. Class members will review, consider, and evaluate each presentation for originality. The students will discuss each idea and consider its validity. They will discuss other past construction materials, designs, and processes. They will transfer the best ideas into one class design.

Teaching Tips

1. Adjust the time frame to meet the needs of your students.
2. Encourage creative thinking by your students.
3. Discuss the importance of futuring with your students.
4. Have students work in groups to design and construct a three-dimensional model to help illustrate their futuristic construction designs.
5. Gather as many different resources as possible, e.g., issues of *Popular Science, Popular Mechanics, TIES* magazine, and other associated publications.
6. Record appropriate segments of the Discovery Channel's program "Beyond 2000" that relate to future construction concepts.
7. Arrange for a guest speaker to talk to your class about future trends in construction and architectural design.
8. If there is time after the final evaluation, compile the best ideas into a list. Divide the class into four or five groups, then have each group design a house that incorporates the best ideas into one structure.

Instructional Strategy

Use current materials from magazines and videos to present the topic to create interest and stimulate the imagination. Monitor each group for participation and understanding. Provide a variety of materials to encourage a number of innovative ideas in modeling. Give positive feedback on all ideas. Use the evaluation to expand and extend ideas and information.

Equipment/Supplies

- Foam-core board
- X-acto knives
- Hot glue guns and glue
- Drawing paper
- Architectural scales
- Pencils
- Other materials as needed

Evaluation Key

Teacher evaluation should be based on participation in and completion of the activity.

Support Materials
Current events materials
School librarian

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be easily modified to meet the needs of special students. Adjust the time frame and/or team special-needs students with non-special-needs students, as needed. Suggest scheduling special education students into your smaller classes. Engage a "helping teacher" to assist.

INTRODUCTION TO FUTURING—CONSTRUCTION SYSTEMS

Activity Overview

This activity is the third in a series relating to futuring. In this activity students will work in small groups to explore futuring and its association with construction systems.

Challenge Statement

Creative thinking, innovation, imagination, and forecasting are important elements for students to explore. You can develop these creative skills to design and build homes for the future.

Objectives

- To discuss and describe future trends in construction materials, methods, and practices
- To design and construct a basic three-dimensional model that can be used to illustrate a design concept

Vocabulary/Concepts Reinforced

- Modularized construction
- Panelized construction
- Space-based construction

Equipment/Supplies

- Foam-core board
- X-acto knives
- Hot glue guns and glue
- Drawing paper
- Architectural scales
- Pencils
- Other materials as needed

Introduction

Future construction techniques will probably not vary greatly from the techniques that are employed today unless construction material and labor costs make conventional construction too expensive. There are, however, trends in construction that will probably find pockets of use in the future. The use of modularized components and panelized sections will find greater acceptance in the areas of conventional construction. Sooner or later, prefabricated housing will improve in both quality and acceptance and will become the norm rather than the exception. Sears may once again offer home-building kits as it once did in the mid-1950s.

The biggest challenges in the area of construction will be space-based construction, in which space station structures will be fabricated in outer space. A whole new generation of construction workers will be trained to travel into space onboard shuttle-type spacecraft to assemble these types of structures. New materials, tools, equipment, joinery, and transportation systems will be used to make these construction projects possible. Space-based construction projects are already on the drawing board and will become reality within a few short years.

Procedure

1. Your instructor will divide the class into small groups. Each group will meet to discuss futuristic construction techniques and develop a type of construction practice that may be common fifty years from now.
2. Your group can select either future conventional construction here on earth or space-based construction. The group will prepare a set of basic drawings that illustrate a futuristic design and construct a three-dimensional model to demonstrate the design.
3. Upon completion of the activity, the teacher will have each group present its project to the class for discussion. Each group should be able to explain its project and justify its design based on futuristic thinking.
4. As a class, make a list of what you agree to be the best ten to fifteen ideas.

Evaluation

Your grade will be based on your participation in and completion of the activity according to your teacher's standards.

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 39
(VARIABLE)

COMPUTER SYSTEM SIMULATION—SIM CITY

Essential Elements: 2, 4, 6, 12
TAAS Objectives: Language Arts: RC 1–6

Activity Overview

This activity is intended to provide students with an opportunity to work with a new and interesting approach to learning called "system simulation." The activity not only presents some very interesting scenarios, but also will help students understand many of the dynamics affecting the day-to-day management of a city. SimCity is a commercially available software for both Macintosh and IBM-compatible computers.

Challenge Statement

Modeling and simulation techniques have been used to educate and train people for many years. These techniques have proven to be valuable training systems, as they provide either direct or close approximations to real-world situations. Simulation techniques are some of the most powerful training programs because the process is highly effective. It is important for students to understand that, if they continue their education, simulation is a process they will very likely encounter in the future.

Systems Model

Resources
Background information
Computer
Software

Processes
Working through the simulation educational experience also includes the process of learning.

Applications
Simulation
Gaming
Technology

Impact
Creativity
Computer technology

Interfacing with Other Disciplines

Language Arts: Students will record ideas about planning a city in a visual form, then participate in a discussion and make a list of important factors in city planning.

Mathematics: Students will use math skills in creating a visual presentation of a simulated city.

Science: Students will consider many elements, including natural disasters and pollution, in planning their cities.
Social Studies: Students will discuss the importance of city planning.

Critical Thinking Skills Reinforced

Students will analyze information, predict, and rearrange their strategies as they work the simulation. Elements of synthesis are used in planning and developing solutions to problems presented in the simulation. Evaluation is presented to the simulation player by feedback from the computer program.

Teaching Tips

1. The instructor should spend some time working through the simulation prior to releasing it to students.
2. Instructors may want to show a small group of students how to use SimCity, let them work through it, and then have them teach another group. This "passing along" will facilitate thorough learning of the activity.
3. Use the activity as either an individual or small-group project.
4. Emphasize the importance of simulation as a training process.
5. A technical manual supports the software program; you should cover this, and make a copy available so students can refer to it as needed.
6. Allow students to compare their cities to expand and transfer ideas.
7. Encourage all students to give input into the Important Factors for Cities list.
8. If there are not enough computers to allow the entire class to participate at one time, have the remainder of the class research innovative cities and city planning until their time comes. This will help students with their designs and provide more suggestions for important factors in city planning.

Instructional Strategy

Demonstrate the use of the simulation to students to cultivate ideas and interest. Monitor the students throughout the activity. Ask questions to check for understanding and to emphasize concepts and processes. Reteach if necessary. Encourage teamwork and idea sharing. Upon completion of the activity, have a class discussion about the effectiveness of the simulation process as an instructional and training method and to list important factors in city planning and design.

Equipment/Supplies

1. Personal computer
2. SimCity software

Evaluation Key

Evaluation of student performance should be based on participation in and completion of the simulation. Further evaluation may be made based on a printout of each student's city.

Support Materials

1. Personal computer
2. SimCity software

Modifications for Handicapped, Disadvantaged, and LEP Students

Most students should be able to work through this activity without difficulty. It may very well prove to be a good learning experience for disadvantaged students, because it illustrates the dynamics involved in operating a city. Teaming special-needs students with non-special-needs students may facilitate learning the program.

COMPUTER SYSTEM SIMULATION—SIM CITY

Activity Overview

This activity focuses on the computer system simulation SimCity, which simulates the planning and management problems encountered in operating a city. The simulation deals with several aspects of city planning and management, including housing, availability of jobs, land value, city services, taxes, zoning, public opinion, crime, pollution, and natural disasters.

Challenge Statement

Computer simulations are used in industry and the military to train and educate personnel. You will have the opportunity to develop a city using computer software.

Objectives

- To use the basic computer hardware and software to operate the simulation program
- To complete at least the basic, or easy, level of difficulty
- To explain, at the conclusion of the simulation, the factors affecting the overall condition of the city
- To show another student how to set up and use the simulation program
- To describe how a simulation system can be used to train or teach someone how to do something

Vocabulary/Concepts Reinforced

- System simulation

Equipment/Supplies

- Personal computer
- SimCity software

Introduction

Simulation and gaming have long been an important part of both industrial and military training and education. The military has relied on simulation training for many years and realizes the many benefits it provides to its personnel. The military uses sophisticated devices to simulate aircraft flight, operation of ships at sea, driving a tank into battle, and many other activities. Simulation devices are highly useful in so many areas chiefly because of their efficiency in providing hands-on training that closely resembles the real thing, yet eliminates the danger and high cost of operating the real thing.

Students who continue their education beyond the high school level will likely encounter training devices that simulate some particular activity. It is important, therefore, that you develop a sense of the simulation process.

Procedure

1. Your instructor will demonstrate the use of SimCity to you, either in small groups or individually.
2. If this is your first time to play the simulation, it is advisable that you select "Easy" from the Game Play menu.
3. As you work through SimCity, save your data from day to day. Use the "Save As" command from the file menu the first time you save your city to a disk.
4. Use the "Print City" command to print a copy of your city. Your instructor may want to use this as part of your evaluation of the project.
5. Discuss factors that you think are important in the design of a city. Make a class list to compare with other classes.

Evaluation

Your evaluation will be based on participation in and completion of the activity. Your instructor may want you to print a copy of your city at the conclusion of your game for a grade.

THE BOAT HULL DESIGN CHALLENGE

Essential Elements: 1, 2, 6, 7, 12, 13, 15, 18
TAAS Objectives: Language Arts: RC 1–5
Mathematics: C 1–5; O 1–4; PS 1–4

Activity Overview

Each student will design and construct two model boat hulls (best and worst) and test them against a speed-to-weight-carrying ratio.

Challenge Statement

Whether small or large, all floating objects have some shared characteristics. This exercise will demonstrate how marine technology concepts, when used appropriately, can be used to help or hinder marine transportation. The student will also realize the complexity of hydrodynamic designing.

Systems Model

Resources
Testing trough
Modeling equipment
Styrofoam
Ballast materials
Background information
Energy source

Processes
Brainstorming
Designing
Testing
Evaluating

Application
Economic concerns
Importance of marine technology
Hydrodynamic engineering

Impact
Consumerism
Informed students
Design skills

Interfacing with Other Disciplines

Language Arts: Students will follow a sequential set of directions to design and construct two boat hulls for testing.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement and fractions to construct two boat hulls.

Science: Students will apply physical science principles to design and construct two boat hulls.

Social Studies: Students will become aware of the great amount of work and detail necessary to build safe boats for transporting people and things.

Critical Thinking Skills Reinforced

Students will use the knowledge and concepts covered in the classroom to solve a transportation problem in a hands-on activity. The students will design, construct, and test two boat hulls, then expand and extend information by observing and analyzing not only their own work, but also the work of other students.

Teaching Tips

1. Let the students view the testing tank before allowing them to start designing.
2. Make sure that the students have all the same material to ensure that the testing is fair.
3. An instructor model showing good and bad design can speed up the design process.
4. Use a ballast material made of lead shot.
5. This is a competition activity that requires creative problem solving.
6. Complete all boat hull testing for all classes, sort, and post the results.
7. It is appropriate to give awards for best design, worst design, and originality of design.

Instructional Strategy

Introduce a brief explanation of the principle of buoyancy through lecture. Conduct a discussion of all the uses of water transportation. Demonstrate how to rough out a boat design on paper and Styrofoam, then demonstrate the testing of a model boat in the testing trough. Encourage creative problem solving by stimulating ideas through questions and brainstorming.

Equipment/Supplies

1. Styrofoam
2. Testing trough for the competition
3. A smaller testing tank to measure the load each hull will carry
4. Ballast material (250 g)
5. Layout and modeling tools for shaping and finishing the Styrofoam
6. Hot wire cutter
7. White glue
8. Small eye hook
9. Water supply
10. Stopwatch

Evaluation Key

It is suggested that all students enrolled in Technology Systems classes compete for a grade against each other. Interclass competition generates a great deal of enthusiasm and should motivate students to do a better job, since the field they are competing against is larger and unknown.

Test the boats three ways:

1. Test the boat hull resistance by attaching a line to the front of the boat and pulling it down a trough of water. Measure the time taken for each boat to complete this test.
2. Test the hull for cargo mass by placing a thin rod exactly in the center of gravity (marked on each boat by the student). Slide the weights down the rod until the boat capsizes (common washers work well).

Support Materials

Schwaller, Anthony E. *Transportation, Energy, and Power Technology.* Albany, N.Y.: Delmar, 1989.

Modifications for Handicapped, Disadvantaged, and LEP Students

This project should not pose a problem for most students. Some students may need help manipulating tools and materials. Gifted and talented students can be challenged by increasing the complexity of the project or modifying the construction materials used for the hull design.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 40

THE BOAT HULL DESIGN CHALLENGE

Activity Overview
Why do some boats go faster than others? Why do small pleasure boats and large cargo ships look so different? In this project you will explore these questions and others.

Challenge Statement
You will need to make two boat hulls. Each boat will show your skill in designing and construction. The hulls will each be tested for their speed and ability to carry weight. One hull should be designed to carry a heavy load but be very fast. The other hull should be made to carry no weight whatsoever and be extremely slow.

Objectives
- To build two working boat hulls in the lab
- To test your hulls and record your results
- To develop an understanding of water transportation and boat construction

Vocabulary/Concepts Reinforced
- Ballast
- Fore
- Knot
- Dtarboard
- Yaw
- Bow
- Hull
- Port
- Starboard
- Draft
- Keel
- Rudder
- Stern

Equipment/Supplies
- Styrofoam
- Testing trough for the competition
- A smaller testing tank to measure the load each hull will carry
- Ballast material (250 g)
- Layout and modeling tools for shaping and finishing the Styrofoam
- Hot wire cutter
- White glue
- Small eye hook
- Water supply
- Stopwatch

Procedure
1. Participate in a discussion of the history of water transportation. Think of as many types of water transportation as you can.
2. Using the tools and equipment provided by your teacher, design and construct two boat hulls with the following rules:
    - Each student will work by him- or herself.
    - To qualify for testing, the boat hull must fit into an imaginary box that is 5" wide and 12" long but has no height limit.

- The hull must be made of only Styrofoam. The boat may be made in layers but must be glued with only white glue provided by the teacher.
- The hull cannot be coated with any material such as glue or resin.
- The boat must be made to carry a load of 250 g of a standard ballast material inset flush into the hull. This is provided by the instructor.
- The ballast material must not interfere with the testing rod used in evaluating the cargo mass capacity.
- A small eye hook will be placed on the bow of each hull in order to fasten the towing line.
- Each boat must have printed on its hull in the appropriate places the following designations: *Bow, Stern, Port, Starboard,* and *Center of Gravity.*

3. Draw detailed plans for your instructor to review before construction.
4. Test each boat in the trough. Record your results.
5. Compare all boats for speed and weight capacity. What observable differences do you notice between the highest scoring boat and the lowest? Are there major construction differences?

Evaluation

All Technology Education students are competing against you. Your two boats will be tested for speed and weight-carrying capability. The hulls will be tested with the ballast in place. Each student is required to hook up the boat to the testing line. The highest score will be 100%. The lowest score that can be received is a 70% (if two hulls are made and tested).

TESTING DOME DESIGNS

Essential Elements: 1, 2, 15, 18
TAAS Objectives: Language Arts: RC 1–5
Mathematics: C 1–5; O 1–4; PS 1–4

Activity Overview
Before the dome competition, basic design members will be tested using Young's Modulus. The post and lintel, arch, and truss will be tested for stress and strain characteristics. From this data table, the students will analyze the results of (1) stress, (2) strain, and (3) Young's Modulus ratio.

Challenge Statement
The problem has three phases: (1) construction, (2) data collection, and (3) analysis of the data. Each student team of two will cut from cardboard a 3" x 1/2" post, a 3" x 1/2" lintel, a 3" x 5" piece of cardboard that will contain an arch at least 1/2" from the top and the sides, and a truss (triangle) that will be constructed from three pieces to form a 3" x 3" x 5 1/2" triangle (see dome parts template). The students will test different designs to see which members are the strongest. From this data collection, they will analyze their hypotheses for the dome contest.

Systems Model
Resources
Background information
Tools and materials
People

Processes
Brainstorming
Designing
Researching
Problem solving

Applications
Model making
Engineering
Gathering data
Analyzing data

Impact
Teamwork
Design

Interfacing with Other Disciplines

Language Arts: Students will make a hypothesis about structural members, then follow sequential directions to construct and test different design models, and collect and analyze data.

Mathematics: Students will add, subtract, divide, multiply, and work with measurement and fractions. They will determine stress and strain factors on different structural supports.

Science: Students will apply physical science principles to predict, test, and analyze structural loads.

Social Studies: Students will become aware of the great amount of work and detail necessary to build safe structures for living, working, and relaxing.

Critical Thinking Skills Reinforced

Students will make hypotheses to determine which design member is strongest. They will test each structure and collect, interpret, and analyze data. They can then plan dome building strategies by applying the data collection.

Teaching Tips

1. Use groups of two students each.
2. The testing apparatus should be ready and built for the students to examine (see Testing Device Sheet).
3. Cardboard used should be of posterboard thickness or thicker (about 1/8" thick).
4. Joints of post and lintel, arch, and truss should be mitered with the utility knife. Safety is a major concern while working with utility knives.
5. Teachers need to monitor these joints closely by walking around and observing construction of these joints by the student teams.

Instructional Strategy

Introduce the topic by showing examples of various structures. Discuss the importance of building safe structures and the risk of careless choices. Save time by having adequate supplies organized in advance. Monitor the students for safety. Ask each student questions during the hands-on activity to check for understanding. Assist students with math computations and allow them to use calculators. The exercise is self-evaluating with the stress test.

Equipment/Supplies

1. Stress and strain measuring devices
2. Utility knife
3. No. 10 tin can with top completely removed
4. 20 lb of sand
5. Ounce or gram scale
6. Bubble level
7. Cardboard
8. Calculator
9. White wood glue
10. Ruler
11. Pencil
12. Dome Parts Template
13. Dome Worksheet
14. Testing device instruction sheet

Evaluation Key

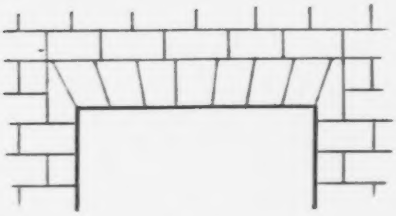
One third of each student's grade will be based on accurate construction of the dome parts, one third on data entry and data table construction, and one third on a written conclusion.

Support Materials

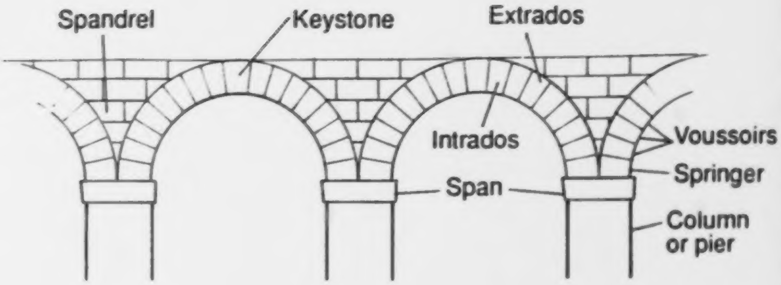
1. Transparencies 41-1 through 41-5
2. Dome Parts Template
3. Dome Worksheet
4. Testing device instruction sheet

Modifications for Handicapped, Disadvantaged, and LEP Students

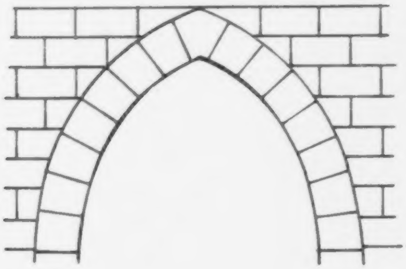
This challenge can be used with any level of proficiency. Care must be exercised regarding initial math readiness. Presented in a positive manner, substitution into formula should be relatively easy to present to students. Measurement should be accurate to 1/8 inch.



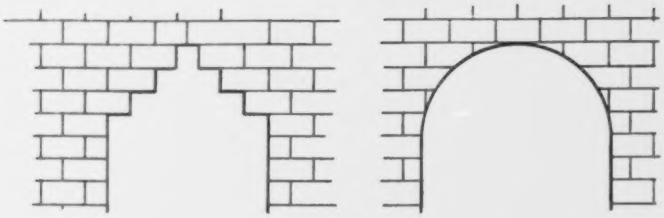
Flat



Round



Pointed

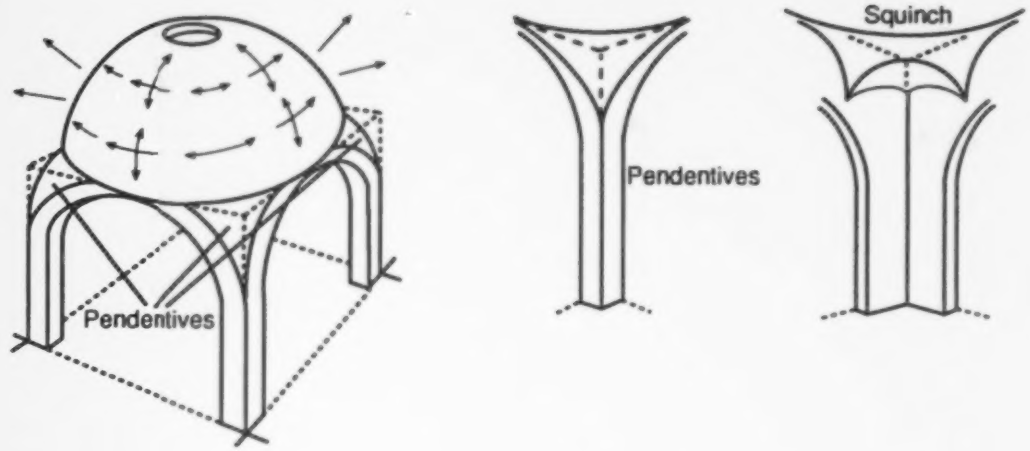


Corbeled arches

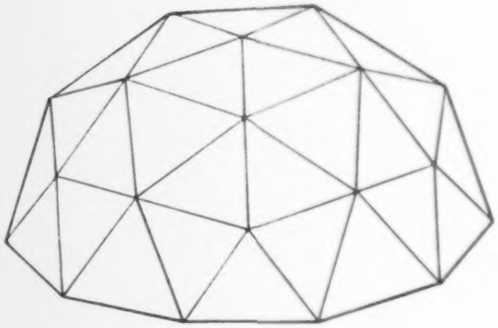
Arch

The arch can be used to span wide openings. If used in multiple, each arch tends to counteract the force of the other.

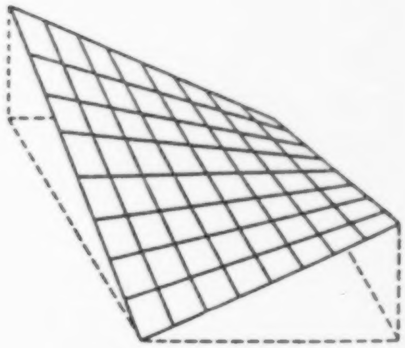
TRANSPARENCY 41-1



The dome and its supports



Geodesic dome

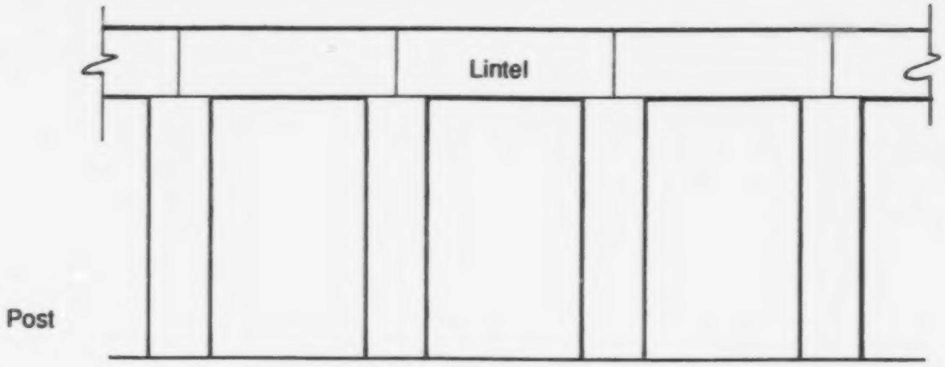


Hyperbolic paraboloid

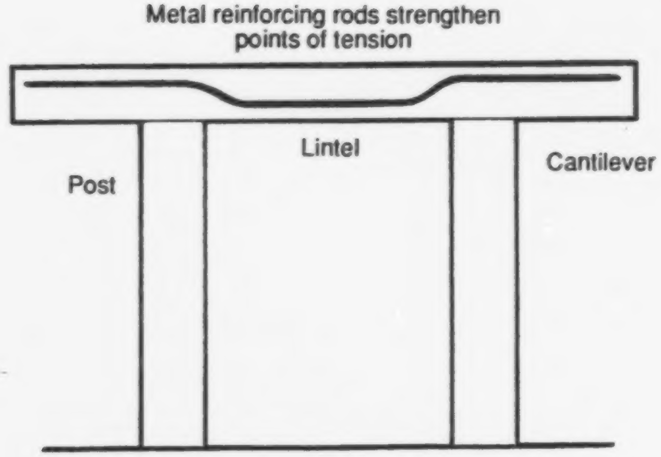
Dome

Byzantine builders perfected the dome, which also evolved from the arch. In its simplest form, the dome may be thought of as a continuous series of arches which intersect (cross) at their highest point (apex).

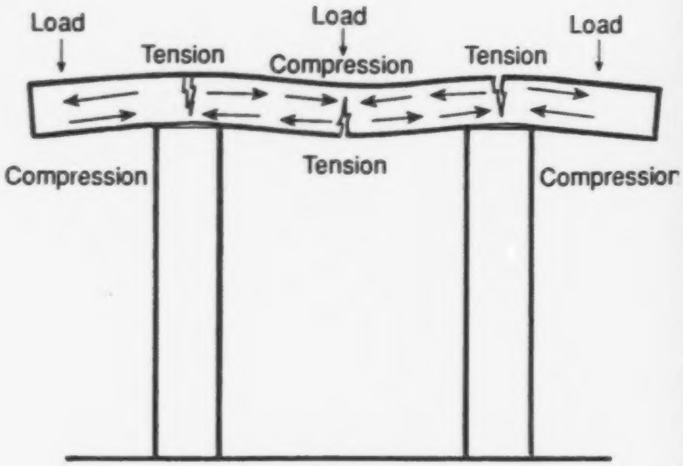
Geodesic domes were developed in the twentieth century by designer Buckminster Fuller. They are spherical (round) forms created by triangular facets (flat surfaces) framed by lightweight tubular struts.



Roman architecture made use of this post and lintel construction.



Concrete

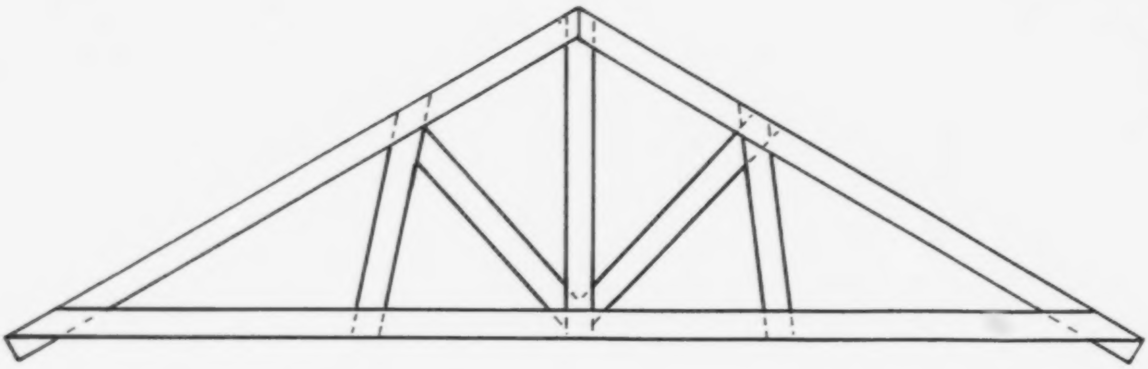


Reinforced concrete

Post and Lintel

This is the simplest form of load and support construction. This is the basis for all openings such as doors and windows. The system is comprised of two or more upright posts of columns and a lintel, placed horizontally across their top surfaces.

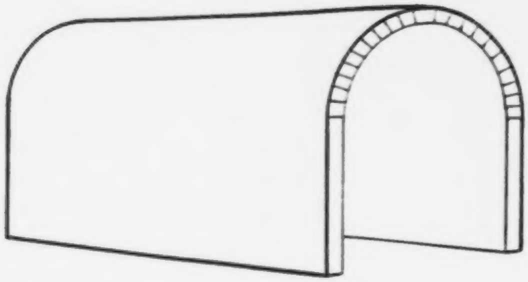
TRANSPARENCY 41-3



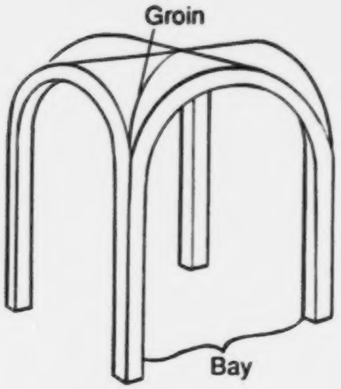
Truss

The truss is based on the geometric law that a triangle is the only figure that cannot be changed in shape without change in the length of its sides. The truss cannot be deformed by its own load or by external forces such as wind pressure. When spaces become too great to span with a single triangle,the simple triangle is replaced by a series of small triangles within a frame, forming a truss.

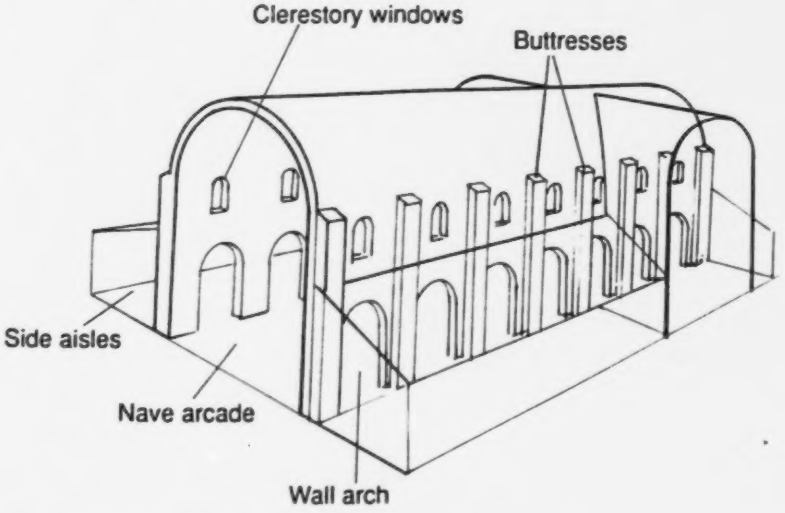
TRANSPARENCY 41-4



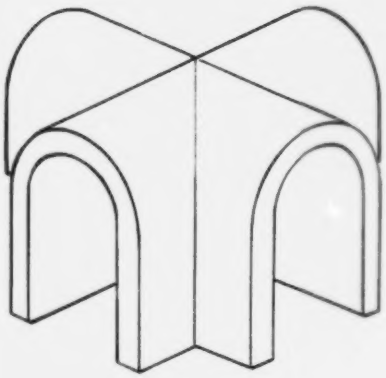
Tunnel vault



Cross vault



Tunnel vault on a Romanesque church



Vault

The vault is an arch deep enough to cover a three-dimensional space. The Romans discovered that openings could be made by intersecting two of the three-dimensional arches at right angles.

TRANSPARENCY 41-5

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 41

TESTING DOME DESIGNS

Activity Overview

Before the dome competition, basic design members will be tested using Young's Modulus. The post and lintel, the arch, the truss, will be tested for stress and strain characteristics. From this data table, the students will analyze the results of (1) stress, (2) strain, and (3) Young's Modulus ratio.

Challenge Statement

The problem has three phases: (1) construction, (2) data collection, and (3) analysis of the data. Each team of two will cut from cardboard a 3" x 1/2" post, a 3" x 1/2" lintel, a 3" x 5" piece of cardboard that will contain an arch at least 1/2" from the top and the sides, and a truss (triangle) that will be constructed from three pieces to form a 3" x 3" x 5 1/2" triangle (see dome parts template). Then you will test different designs to see which members are the strongest. From this data collection, you will analyze your hypotheses for the dome contest.

Objectives

- To make a hypothesis about which type of construction method (post and lintel, arch, truss triangle) will take the most stress and strain
- To explore and apply the formulas for stress, strain, and Young's Modulus
- To measure and extract accurate data
- To analyze the team's data and compare its results with its initial hypothesis
- To interpolate the team's data and use this data for the construction of a dome for the contest

Vocabulary/Concepts Reinforced

- Structural methods
- Hypothesis making
- Accurate measuring skills
- Principles of compression and tension
- Post and lintel
- Truss
- Arch
- Stress
- Strain
- Young's Modulus
- Elasticity

Equipment/Supplies

- Stress and strain measuring devices
- Utility knife
- No. 10 tin can with top completely removed
- 20 lb of sand
- Ounce or gram scale
- Bubble level
- Cardboard

- Calculator
- White wood glue
- Ruler
- Pencil
- Dome Parts Template
- Dome Worksheet
- Testing device instruction sheet

Procedure

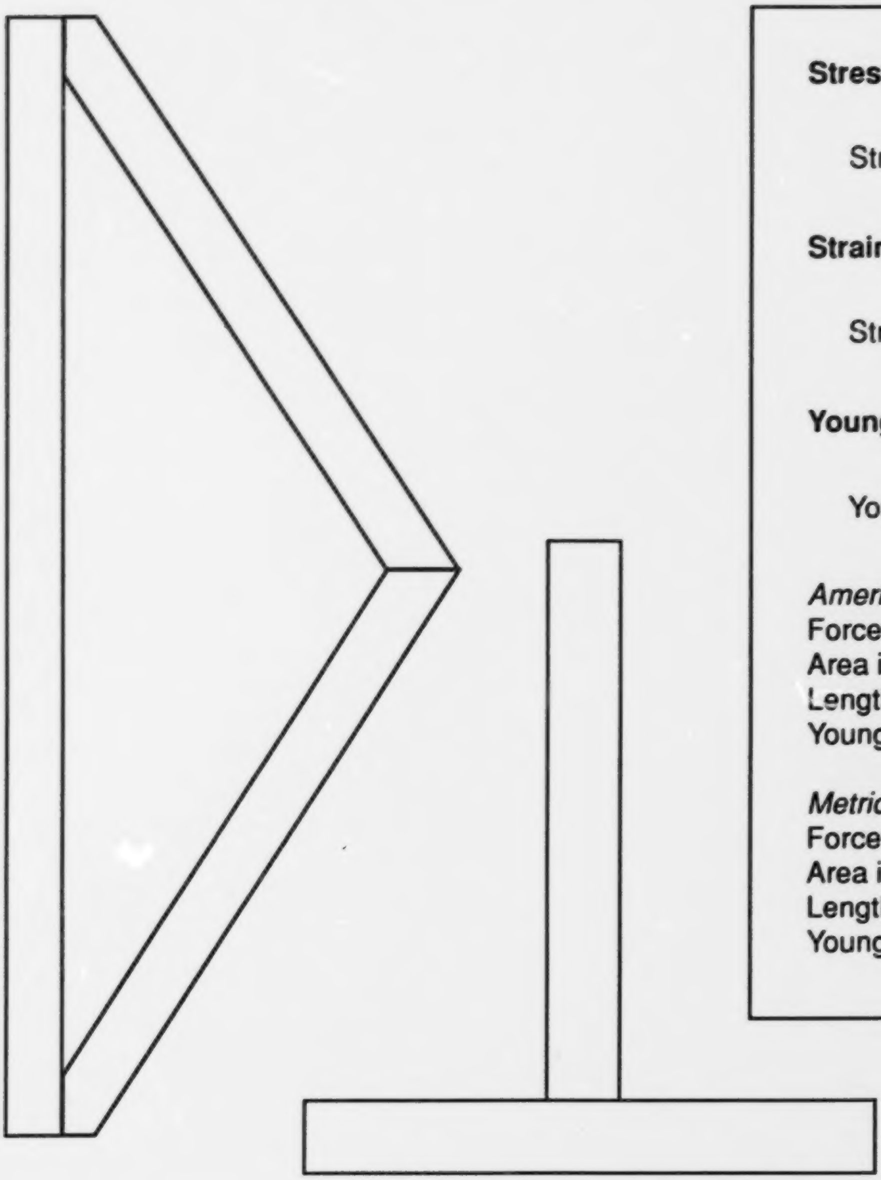
The teams will be composed of two students each.

1. Make a hypothesis about which construction member will withstand the most stress and strain. Write this hypothesis down.
2. Cut out and construct the construction members for testing. Use the template for the dome.
3. After gluing and drying, place the post and lintel, the arch, and the truss into the testing device. At the first sign of deformation in the structure in stress and/or stain, record your data accurately on the data table. Use the correct formula setup for Young's Modulus.
4. Using Young's Modulus, calculate the stress and strain ratio.
5. Record this answer in the data table.
6. Find *two* other teams' data. Record these in your data table.
7. Find the average stress, strain, and Young's Modulus for the post and lintel, the arch, and the truss. Record this on your data table.

Evaluation

One third of your grade will be based on accurate construction of the dome parts, one third on data entry and data table construction, and one third on a written conclusion.

DOME PARTS TEMPLATE



Stress Formula

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

Strain Formula

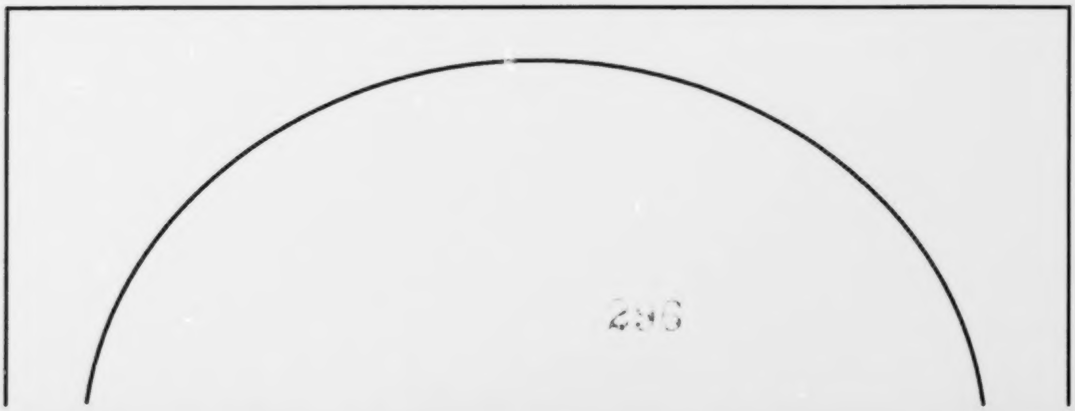
$$\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$$

Young's Modulus

$$\text{Young's Modulus} = \frac{\text{Stress}}{\text{Strain}}$$

American Measurement:
Force in ounces
Area in square inches
Length in inches
Young's Modulus is oz/in.^{2}

Metric Measurement:
Force in grams
Area in square centimeters
Length in centimeters
Young's Modulus is g/cm^2



Dome Worksheet

Name ______________________________

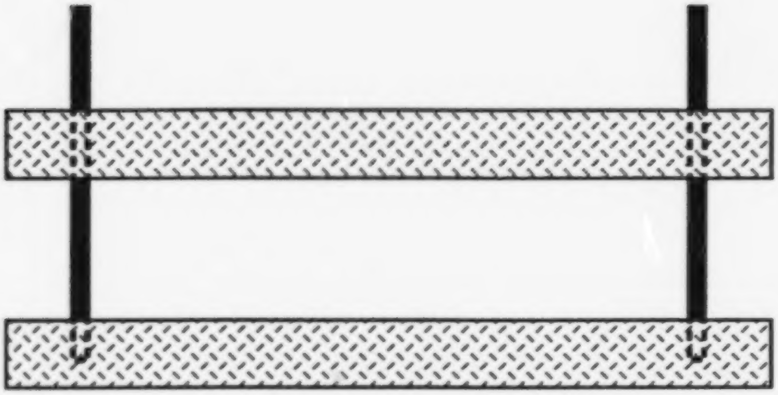
Team ______________________________

	Post + Lintel #1	Arch #1	Truss Triangle #1	Post + Lintel #2	Arch #2	Truss Triangle #2
Stress						
Strain						
Young's Modulus						

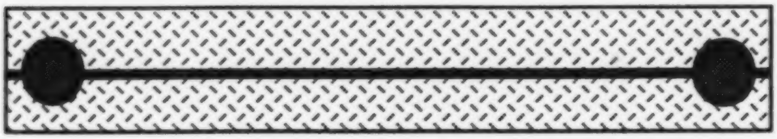
	Post + Lintel #3	Arch #3	Truss Triangle #3
Stress			
Strain			
Young's Modulus			

	Post + Lintel Avg.	Arch Avg.	Truss Triangle Avg.
Stress			
Strain			
Young's Modulus			

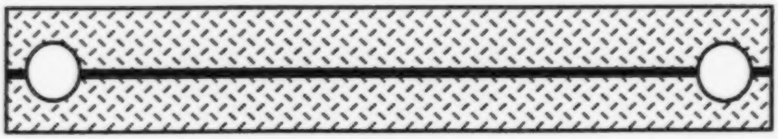
Testing Device Instruction Sheet



1. Cut a 2" x 4" into (2) 12" pieces.
2. Route a 1/8" slot lengthwise into the center of each board.
3. In the top piece, drill 2 holes 5/8" in diameter completely through the end of each side.
4. In the bottom piece, drill matching holes that coincide with the top piece, but do not go completely through the board. Drill the hole only 1/2" deep.



View of **bottom** member



View of **top** member

Bridge Design Challenge

An exercise with in-depth background information to be used as a curriculum integration tool

Technology Systems Section

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 42
(10–11 DAYS)

THE BRIDGE DESIGN CHALLENGE

Essential Elements: 1, 2, 15, 18
TAAS Objectives: Language Arts: RC 1–5; WC 1–4
Mathematics: C 1–5; O 1–4; PS 1–4

Activity Overview
Teams of two students will develop their own bridge design meeting the given criteria. They will make a deduction from the laboratory exercise and the information disseminated by the instructor.

Challenge Statement
Everything we deal with on a day-to-day basis has some form of structure; from the smallest earthworm to the tallest skyscraper, structure holds all things together.

Systems Model
Resources
Background information
Tools and materials
People

Processes
Brainstorming
Designing
Researching
Problem solving

Applications
Model making
Engineering
Gathering data
Analyzing data

Impact
Teamwork
Design

Interfacing with Other Disciplines
Language Arts: Students will make a hypothesis about structural members, then follow sequential directions to construct and test different designs and models, and collect and analyze data.

Mathematics:	Students will add, subtract, divide, multiply, and work with measurement and fractions. They will determine stress and strain factors on different structural supports.
Science:	Students will apply physical science principles to predict, test, and analyze structural loads.
Social Studies:	Students will become aware of the great amount of work and detail necessary to build safe bridges for traveling. They will realize how transportation and roadways advanced with the construction of safe bridges.

Critical Thinking Skills Reinforced

Students will use the knowledge and concepts covered in the classroom to solve a problem by taking the information and solving the problem in a new way in a hands-on activity. The students will expand and extend information by observing and analyzing not only their own work, but also the work of other students.

Teaching Tips

1. Explain to the students the importance of structure and its effects on their everyday lives.
2. Explain and demonstrate the terms and properties that a structural (civil) engineer would use. (Refer to the student vocabulary sheet.)
3. Demonstrate and explain the testing apparatus and the site.
4. Explain all the conditions of the competition to the students.
5. Emphasize each of the terms and properties, using an example or representation of a truss or bridge under each condition.

Instructional Strategy

Introduce the topic by showing examples of various bridge structures. Discuss the importance of building safe structures and the risk to motorists of careless choices. Save time by having adequate supplies organized in advance. Monitor the students for safety. Ask each student questions during the hands-on activity to check for understanding. Assist students with math computations and allow them to use calculators. The exercise is self-evaluating with the stress test.

Equipment/Supplies

1. A room that will allow theater seating for competition, if available
2. Two tables
3. Testing apparatus for the truss analysis section (see physical science portion of this lesson)
4. Testing apparatus for the bridge competition (see Instruction Resource Sheet #1)
5. Balsa wood (or basswood, or spaghetti if funds are low)
6. Wood glue
7. Stick pins
8. Wax paper
9. 11" x 17" paper
10. Scientific calculator
11. Pens and pencils
12. X-acto knives

Evaluation Key

The student teams will be competing for a grade. The team that has the highest strength-to-weight ratio will receive the highest grade. A passing grade (70%) will be given to any team that brings a testable and completed bridge design to the competition. Standard written testing of the information covered in the classroom prior to the competition will evaluate students' comprehension of that information. An identifier checking the level of student comprehension before beginning the competition will serve the same purpose.

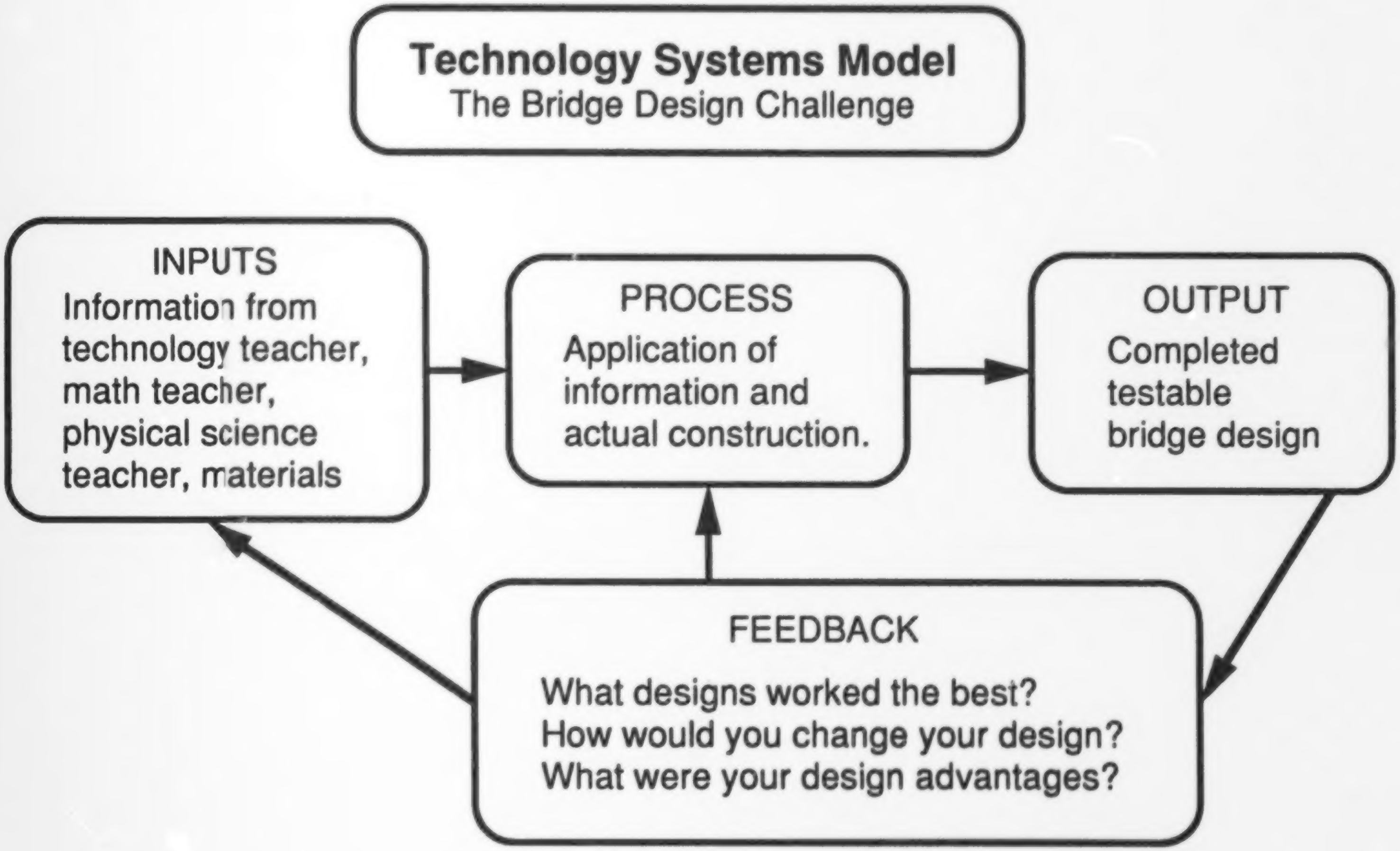
Support Materials

1. Transparencies 42-1 through 42-9
2. Video clips from previous competitions (if applicable)
3. Resource books on production and construction from various publishers
4. Information gained from your math and science departments

Modifications for Handicapped, Disadvantaged, and LEP Students

If you have special-needs students in your class, assign them to different teams. You may also want to have a resource person come in from the special education department to help with individual students as needed.

TRANSPARENCY 42-1



Technology Systems Model
The Bridge Design Challenge

INPUTS
Information from technology teacher, math teacher, physical science teacher, materials

PROCESS
Application of information and actual construction.

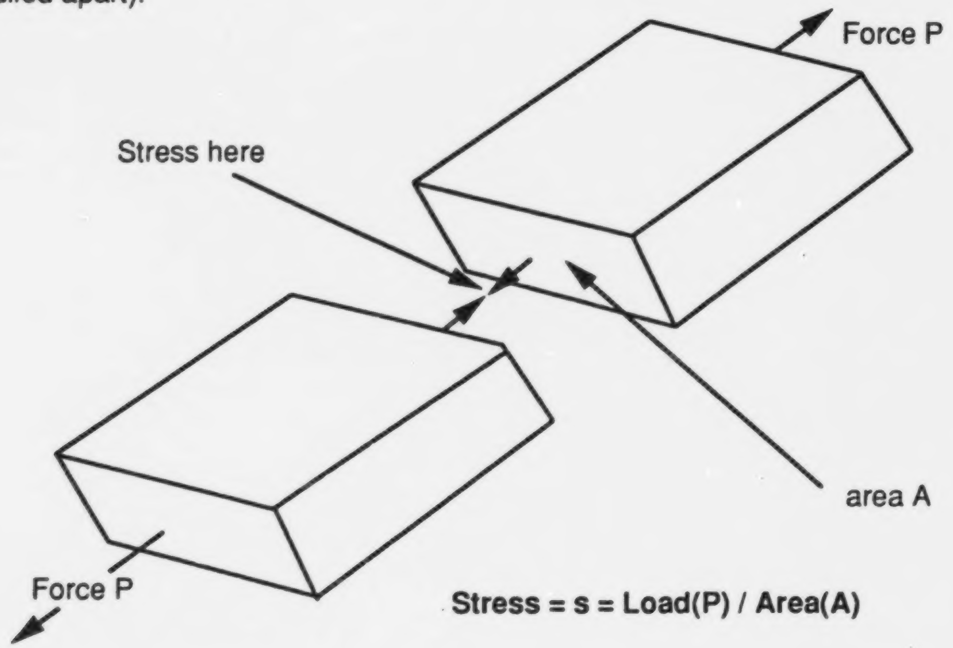
OUTPUT
Completed testable bridge design

FEEDBACK
What designs worked the best?
How would you change your design?
What were your design advantages?

What is Stress and Strain?

Stress

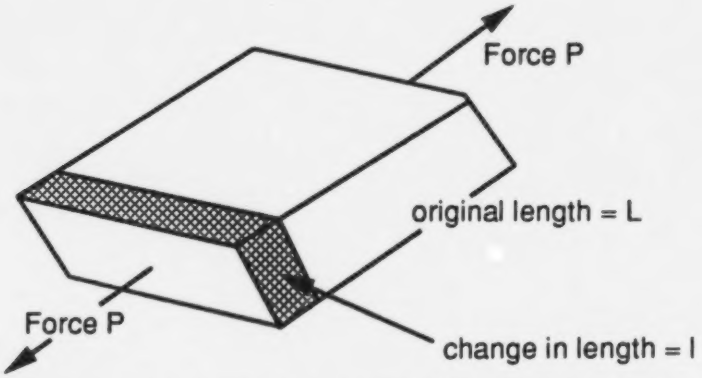
The effect of a mechanical load (force) on the cross-sectional area of an object or material (how much force the atoms of the material at any point in the material are being pulled apart).



Stress = s = Load(P) / Area(A)

Strain

The effect of a mechanical load (force) on how far apart or how close together the atoms of the material or structure being acted upon are.



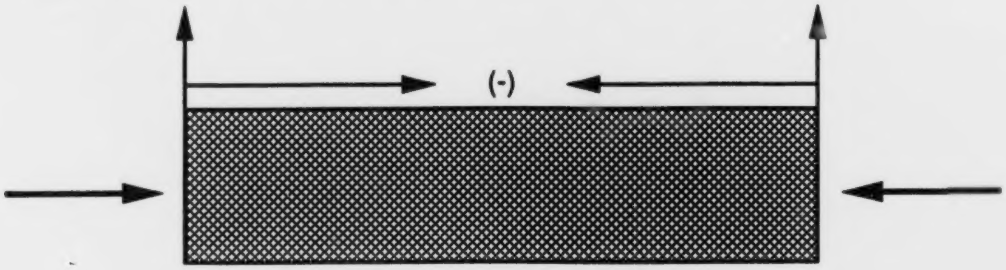
Strain = e = change in length (l) / original length

Engineering strains are usually quite small, and so engineers often express strains in percentages, which reduces the chances for confusion with decimal points. (Make sure to convert back in use when calculating Young's Modulus.)

What is Compression?
What is Tension?
What is Shear?

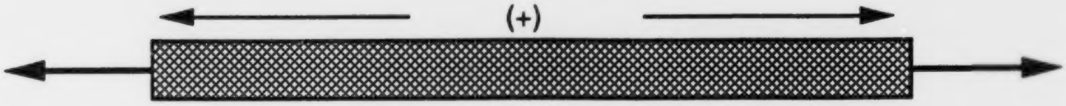
Compression:

A condition in a member or material by the application of opposite **pushing force**. A member under "Compression" tends to be **shortened.** On structural diagrams compression is represented by a negative or minus sign (-).



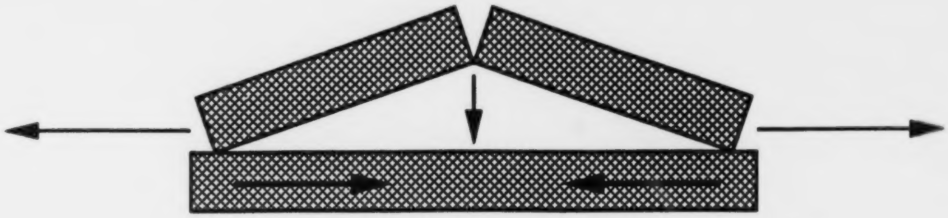
Tension:

A condition in a member or material produced by the application of opposite **pulling forces**. A member under "Tension" tends to **increase** in length. On structural diagrams, tension is represented by a plus sign (+).



Shear:

Shearing strain is a condition in a body caused by forces that tend to produce an opposite but parallel sliding motion. Shearing strain is represented by arrows showing the resulting force.



Why Structures Carry Loads

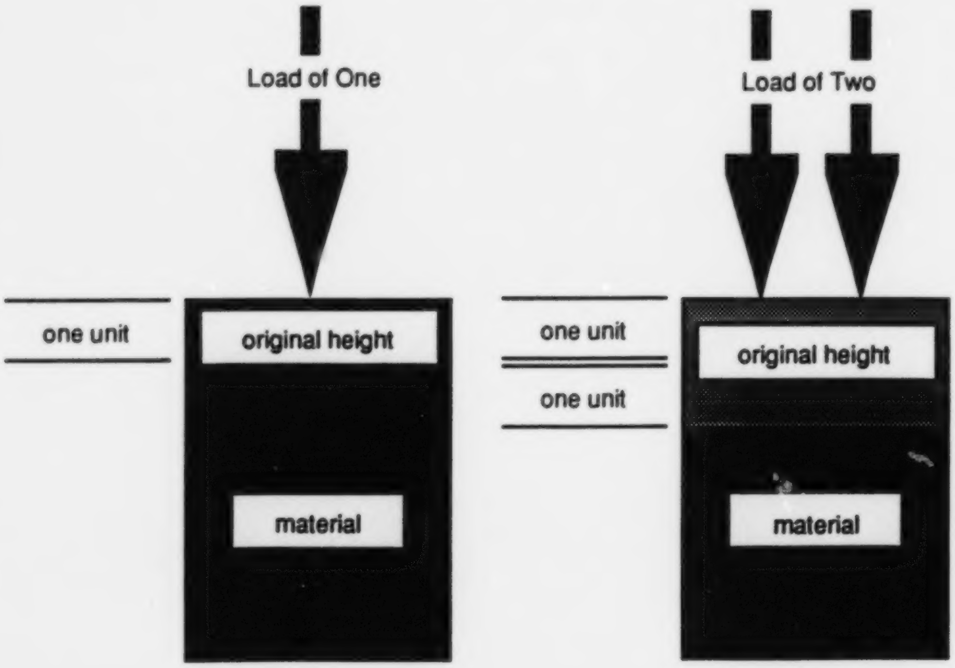
We have all wondered at one time or another, why that bridge doesn't break, or how that tall building keeps on standing. Here is some help in answering those types of questions.

Let's begin with Sir Isaac Newton. He said in his Third Law of Motion that action and reaction are equal and opposite. That for every push or pull there must be a matched opposite push or pull (either active or passive).

Ask yourself the question, "Why do inanimate objects resist a mechanical force (a load) at all or even substain their own weight?" Many of the learned people of the world tried to answer that question but the answer came with a man named Robert Hooke.

Hooke first realized that if a material or structure resists a load, it can only do so with the application of Newton's Third Law of Motion. The study of structures and engineering is the application of certain laws and theories in keeping the forces involved equal or in equilibrium. If the forces are not kept in balance, the material breaks or the structure fails.

Hooke said (in layman's terms): If a load of one stretches or pushes a material a unit of one, a load of two should stretch or push the material a unit of two.



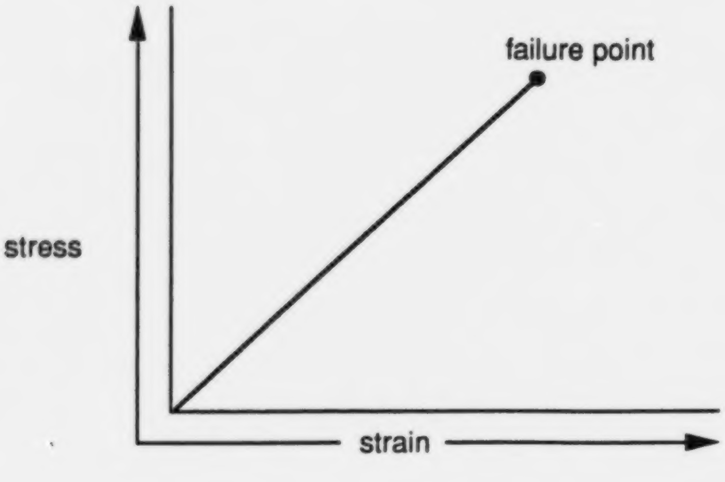
TRANSPARENCY 42-4

We ask the question: why calculate stress and strain? The answer is really very simple. The materials that we use have certain limitations and we need to be aware of these. But does an engineer have to measure all of these? No, most of the materials that are now in use have constants that are already calculated. One of those constants is Young's Modulus, a constant that takes elasticity (or how stiff a material is) into account for each material.

Young calculated the stiffness of materials using the calculations of stress (how much the material changed in length) and strain (the force and change in length).

Stress (s) / Strain (e) = Young's Modulus or E

When a material is tested for stiffness, a changing force (P) is applied on material and stress is measured constantly. The material is tested until failure. Below is an example of a Stress/Strain daigram.



If the Stress/Strain diagram turns out to be a straight line, the material is "Hookean," or follows Hooke's Law.

TRANSPARENCY 42-5

Bridges

The bridge is a structure used by people and vehicles to cross areas that are obstructed to travel, such as valleys, rivers, and overpasses.

Bridges range from a few feet to several miles in length and varied widths.

A bridge must be able to support its own weight in addition to the weight of the people and vehicles that use it.

Bridge structures must also be designed to resist various natural occurrences, including earthquakes, strong winds, and changes in temperature.

Bridge terminology:

Span — the distance between two adjacent supports, see Fig. 1.

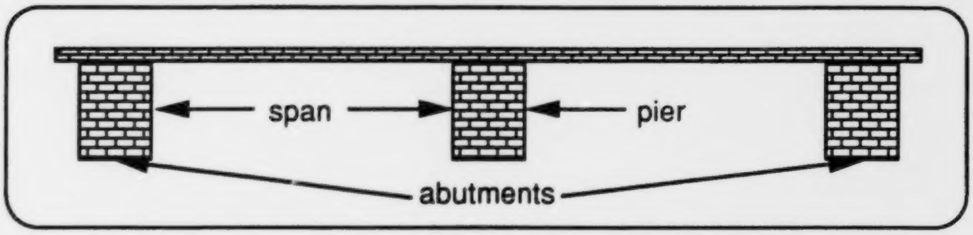


Fig. 1.

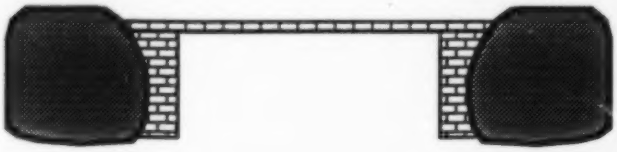
Abutments — the supports that stand at each end of the bridge.
Piers — the supports that stand between the abutments.
Single Span — short bridges supported only by the abutments.
Multi-Span — bridges that have one or more piers in addition to the abutments.
Main Span — the longest span of the multi-span bridge.
Pontoon — a bridge that is supported by flat-bottomed boats.

TRANSPARENCY 42-6

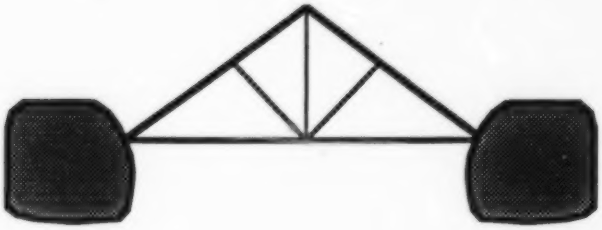
Types of Bridges

There are seven main kinds of bridges:
(1) **girder,** (2) **truss,** (3) **arch,** (4) **cantilever,** (5) **suspension,** (6) **cable-stayed,** and (7) **drawbridge.**

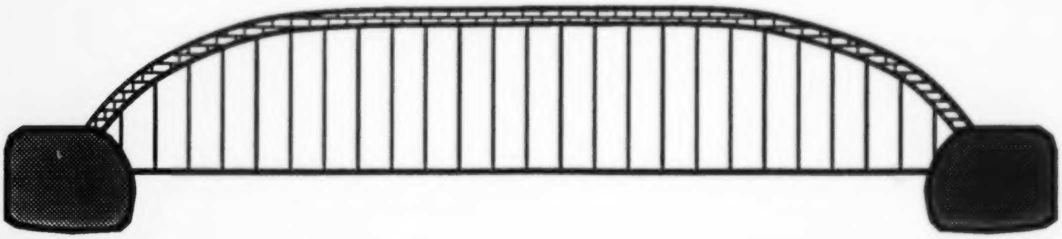
1. *Girder Bridges* — consist of a girder or beam across the abutments.



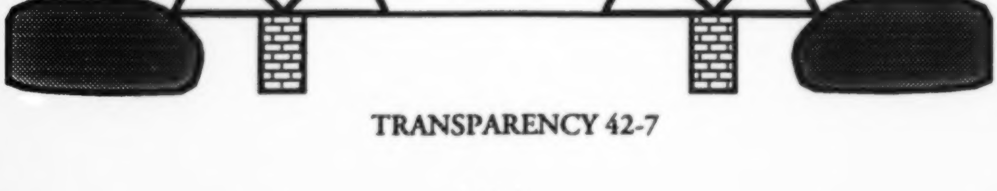
2. *Truss Bridges* — bridges which are supported by a framework. Parts of the trusses are arranged in the form of triangles.



3. *Arch Bridge* — one of the oldest types, this design uses an arch to support the weight of the bridge and its users. Can be seen in ancient Roman and Greek ruins.

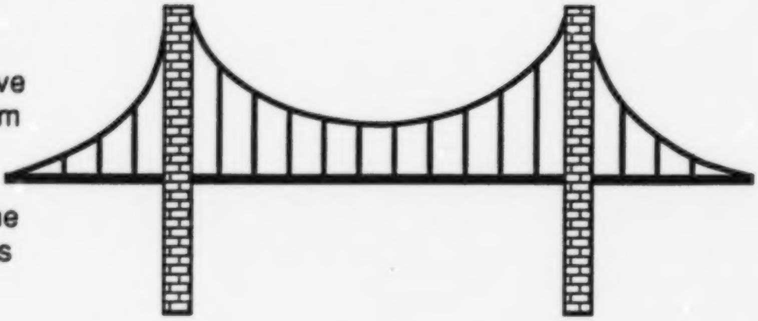


4. *Cantilever Bridge* — this bridge consists of two independent beams called cantilevers that extend from opposite banks of an obstacle. The two cantilevers are joined together above the middle by a beam.

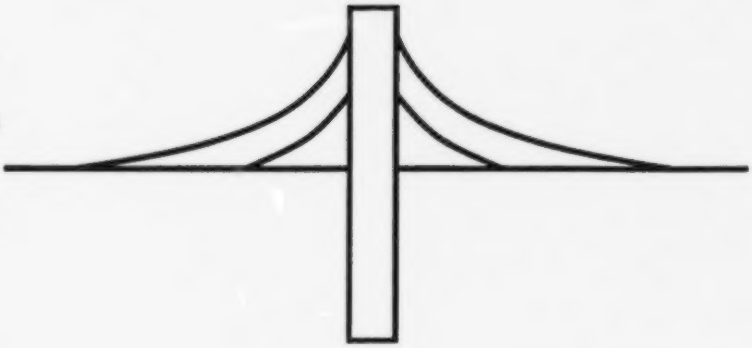


TRANSPARENCY 42-7

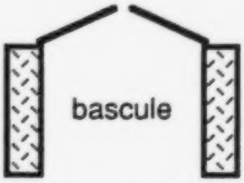
5. Suspension Bridges — these bridges can span great distances. They have a roadway that hangs from steel cables that are supported by two high towers and fastened at the abutments. (Roebling was instrumental in the development.)

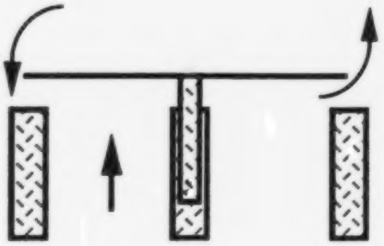


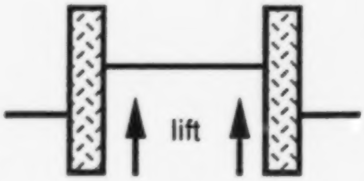
6. Cable-Stayed Bridges — resemble suspension bridges. The difference is that the cables that support the roadway are connected directly to the towers.



7. Drawbriges — this type of bridge has a roadway that is moved entirely or partially to provide enough clearance for large ships to pass. There are three types: Bascule, lift, and swing.

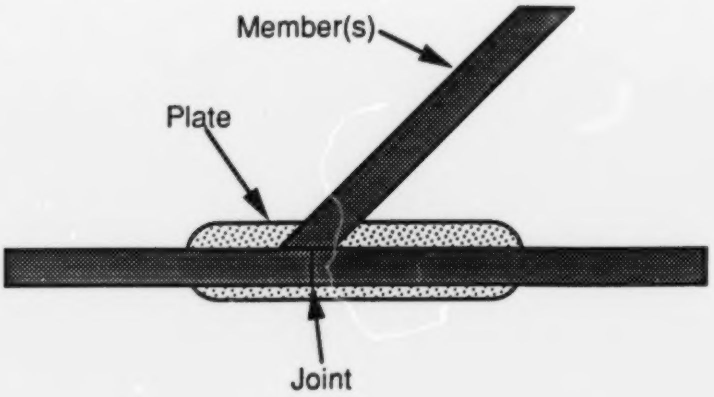


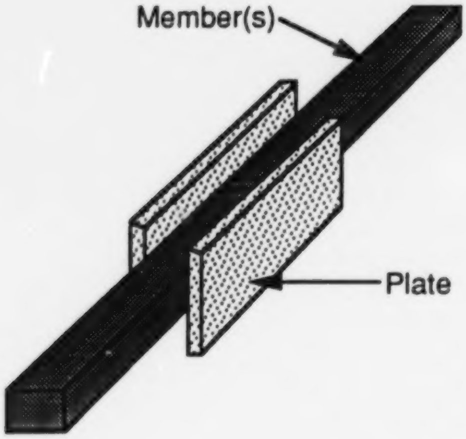




TRANSPARENCY 42-8

Joining Members with a Plate





Keep the following in mind at all times while you are designing;

1) How does your design distribute weight?
2) What stress is each member under?
3) How much stress is focused at each point?
4) How does your design hold the testing device?
5) How will your design stop the two sides from pulling apart when under stress?

THE BRIDGE DESIGN CHALLENGE

Activity Overview
How could you span a raging river with minimal materials, and be able to hold twenty eighteen wheelers?

Challenge Statement
This activity emphasizes that everything you touch and see has structure (what holds it up), and that certain properties, taken into account when designing a structure, will make that structure more efficient.

Objectives
- To use the knowledge and concepts presented to you in the classroom portion of this activity
- To evaluate the properties of structures and materials
- To solve the problem in your own way

Vocabulary/Concepts Reinforced
- Newton's Third Law of Motion
- Tension
- Pontoons
- Arch bridge
- Stress
- Hooke's law
- Force
- Pier
- Cantilever bridge
- Strain
- Compression
- Span
- Girder bridge
- Cable-stayed bridge
- Young's Modulus
- Structure
- Abutments
- Truss bridge
- Draw bridges

Equipment/Supplies
- Balsa wood (or basswood, or spaghetti if funds are low)
- Wood glue
- Stick pins
- Wax paper
- 11" x 17" paper
- Scientific calculator
- Pens and pencils
- X-acto knives

Procedure
1. Build a bridge following these rules and regulations:
    - The bridge must span an 18" gap between two tables.
    - The bridge can be no taller than 6" in dimensional thickness.
    - The bridge can be no wider than 3.5".
    - The center of your bridge must be designed for the testing fixture, which is a 2" x 2" x 1/2" apparatus.

   All students are competing for a grade. The bridge with the greatest strength-to-weight ratio will receive the best grade.
2. Test the strength of your bridge, and record your results on the chart provided.

3. Compare test results. Discuss the configuration of the structure that held the most weight. What are the structural differences between the strongest and the weakest bridge?

Evaluation

You and your partner will be competing for a grade. The team that designs the lightest and strongest bridge will receive the highest grade (100%). A passing grade (70%) is to be the lowest grade given for any team that brings a testable design to the competition. You will be tested on the background information given in lecture before beginning the design competition.

Physical Science Section

PHYSICAL SCIENCE
INSTRUCTOR'S RESOURCE SHEET 42
(3 DAYS)

THE BRIDGE DESIGN CHALLENGE

Activity Overview
Before "The Bridge Challenge," basic triangular shapes will be constructed and tested using Young's Modulus. The equilateral triangle, isosceles triangle, and scalene triangle will be tested for stress and strain characteristics. From this data, a data table will be made by students and they will analyze the results to determine stress, strain, and Young's Modulus ratio.

Challenge Statement
Which triangle can withstand more stress and hold more weight—an isosceles triangle, a scalene triangle, or an equilateral triangle?

Systems Model
Resources
Background information
Tools and materials
People

Processes
Brainstorming
Designing
Researching
Problem solving

Application
Model making
Engineering
Gathering data
Analyzing data

Impact
Teamwork
Design

Critical Thinking Skills Reinforced
Students will make a hypothesis about which triangle will be the strongest, test the hypothesis, and collect, analyze, and interpret data. They will plan bridge-building strategies around the data collected.

Teaching Tips
1. Divide the class into teams of two students each.
2. Students will follow the scientific method to prove their hypotheses.
3. Each group will design a data table to record and interpret their data.

Instructional Strategy

Introduce and demonstrate terms such as elasticity, stress, and strain to introduce the topic. Review scientific method if necessary, and then assist groups in making hypotheses. Monitor all groups during testing and data collection. Discuss the methods of testing results of each group as an evaluation and extension of information.

Equipment/Supplies

1. Stress and strain measuring devices
2. 20 lbs. of sand
3. Utility knives
4. 10-lb. can with top completely removed
5. Bubble level
6. Cardboard
7. Wood glue
8. Protractors
9. Rulers
10. Pens or pencils and paper
11. Calculators
12. Bridge Parts Template
13. Bridge Worksheet

Evaluation Key

One third of the student's grade is based on construction of triangles, one third on accurate data table design and data entry, and one third on the quality of the written conclusion.

Modifications for Handicapped, Disadvantaged, and LEP Students

If you have special-needs students in your class, assign them to different teams. You may also want to have a resource person come in from the special education department to help with individual students as needed. Some student will have difficulty with fractions. Offer assistance when needed.

THE BRIDGE DESIGN CHALLENGE

Activity Overview

Before "The Bridge Challenge" in the Technology Systems classes, basic triangular shapes will be constructed and tested using Young's Modulus. The equilateral triangle, isosceles triangle, and scalene triangle will be tested for stress and strain characteristics. From this data, you will design a data table and analyze the results to determine stress, strain, and Young's Modulus ratio.

Challenge Statement

Which triangle can withstand more stress and hold more weight—an isosceles triangle, a scalene triangle, or an equilateral triangle?

Objectives

- To make a hypothesis about which type of triangle will withstand the most stress and strain
- To explore and apply formulas for stress, strain, and Young's Modulus
- To measure, collect, and interpret data to prove a hypothesis
- To draw accurate conclusions through the comparison and discussion of all teams' results

Vocabulary/Concepts Reinforced

- Structural methods
- Hypothesis making
- Scientific method
- Accurate measurement
- Isosceles triangle
- Equilateral triangle
- Scalene triangle
- Compression
- Tension
- Stress
- Strain
- Young's Modulus

Equipment/Supplies

- Stress and strain measuring devices
- 20 lb of sand
- Utility knives
- No. 10 can with top completely removed
- Bubble level
- Cardboard
- Wood glue
- Protractors
- Rulers
- Pens or pencils and paper
- Calculators
- Bridge Parts Template
- Bridge Worksheet

Procedure

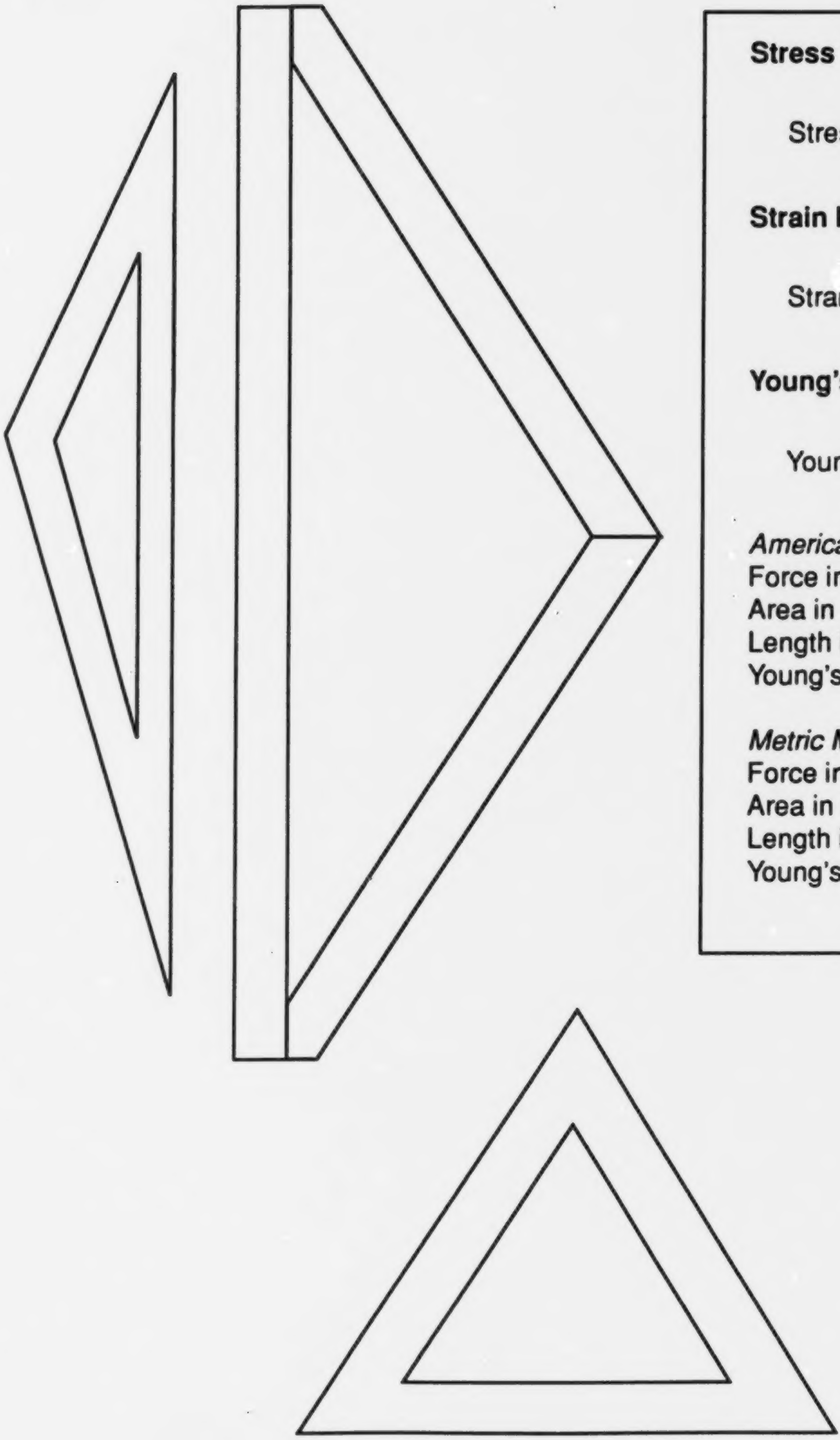
1. Your teacher will divide you into teams. Make a hypothesis about which is the strongest triangle—the equilateral, the isosceles, or the scalene. Write it down.
2. Cut out and construct the triangular pieces for testing. Use the bridge template.
3. Design a chart to record the results of your tests.
4. Place each triangle into the testing device. At the first sign of deformation of the structure, record your data.

5. Use the correct formula for Young's Modulus to calculate the stress and strain ratio.
6. Record your answer in the data table.
7. Record the data from two other teams.
8. Determine the average stress, strain, and Young's Modulus for each of the triangles. Record this on your data table.
9. Discuss your results with the class.

Evaluation

One third of your grade is based on construction of triangles, one third on accurate data table design and data entry, and one third on the quality of your written conclusion.

BRIDGE PARTS TEMPLATE



Stress Formula

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

Strain Formula

$$\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$$

Young's Modulus

$$\text{Young's Modulus} = \frac{\text{Stress}}{\text{Strain}}$$

American Measurement:
Force in ounces
Area in square inches
Length in inches
Young's Modulus is oz/in.^{2}

Metric Measurement:
Force in grams
Area in square centimeters
Length in centimeters
Young's Modulus is g/cm^2

Bridge Worksheet

Name ________________________________

Team ________________________

	Equilateral Triangle #1	Isoceles Triangle #1	Scalene Triangle #1	Equilateral Triangle #2	Isoceles Triangle #2	Scalene Triangle #2
Stress						
Strain						
Young's Modulus						

	Equilateral Triangle #3	Isoceles Triangle #3	Scalene Triangle #3
Stress			
Strain			
Young's Modulus			

	Equilateral Triangle Avg.	Isoceles Triangle Avg.	Scalene Triangle Avg.
Stress			
Strain			
Young's Modulus			

Mathematics Section

MATHEMATICS
INSTRUCTOR'S RESOURCE SHEET 42
(2 DAYS)

THE BRIDGE DESIGN CHALLENGE

Activity Overview
Using basic algebraic skills, the student will compute surface area, stress, strain, load, and Young's Modulus on various sections of their bridges. Through these calculations, the students can mathematically see which designs, in theory, should be better. The final ratios will determine the best design.

Challenge Statement
By measuring various components of their bridges, the students will calculate the different forces acting on the structure.

Systems Model
Resources
Background information
Materials
People

Processes
Synthesis
Testing
Observation
Problem solving

Applications
Math skills to a real-world engineering problem

Impact
Teamwork
Safety
Technology

Critical Thinking Skills Reinforced
Students will apply math knowledge and skills to solve a problem. They will use classroom information to solve problems in a new way. The students will compare results to find the best solution.

Teaching Tips
1. Check students for understanding of ratio and area calculations; reteach if necessary.
2. Ask the technology education teacher for actual blocks or models for the students to use in their calculations.
3. This activity can be timed to use as a summative unit.

Instructional Strategy

Introduce and demonstrate terms such as elasticity, stress, and strain to introduce the topic. Monitor guided practice and reteach necessary techniques. Compare and discuss results.

Equipment/Supplies

1. Overhead projector
2. Pens or pencils and paper
3. Rulers
4. Calculators

Evaluation Key

Students will be graded on participation and the completion of the worksheets.

Support Materials

1. Formula Sheet
2. Area Worksheet
3. Ratio Worksheet

Modifications for Handicapped, Disadvantaged, and LEP Students

You may also want to have a resource person come in from the special education department to help with individual students as needed. Some students will have difficulty with fractions. Offer assistance when needed.

THE BRIDGE DESIGN CHALLENGE

Activity Overview

Using basic algebraic skills, you will compute surface area, stress, strain, load, and Young's Modulus on various sections of bridges. Through these calculations, you can mathematically see which designs, in theory, should be better. The final ratios will determine the best design.

Challenge Statement

By measuring various components of bridges, you will calculate the different forces acting on the structure.

Objectives

- To apply math techniques to real-world situations
- To use ratios to evaluate the efficiency of a bridge design by calculating stress, strain, and Young's Modulus

Vocabulary/Concepts Reinforced

- Area
- Isosceles triangle
- Equilateral triangle
- Scalene triangle
- Young's Modulus
- Strain
- Ratio

Equipment/Supplies

- Overhead projector
- Pens or pencils and paper
- Rulers
- Calculators

Introduction

In the real world, mathematics is used as a basis for evaluating the efficiency of a product. In bridge design, several mathematical concepts can be applied. One is the concept of ratio. A ratio can help you decide what would be the most efficient bridge for a design.

Procedure

1. Define *area,* and calculate the area of different geometric shapes. (Fill out Ratio Worksheet.)
2. Define *ratio,* and simplify several ratios. Write ratios in the form a:b. (Fill out Ratio Worksheet.)
3. Define *stress,* as the ratio of force to area.
4. Define *strain* as the ratio of change in dimension to original dimension.
5. Define *Young's Modulus* as the ratio of stress to strain.

Evaluation

You will be graded on class participation and the completion of the worksheets.

Formula Sheet

ABBREVIATIONS:

Base = b
Height = h
Radius = r
Stress = s
Strain = e
Area = A
Force = F
Load = P

AREA:

Rectangle = $b*h$
Right Triangle = $\frac{b*h}{2}$
Circle = $\pi*r^2$
Parallelogram = $b*h$
Trapezoid = b_1*b_2*h

PYTHAGOREAN THEOREM:

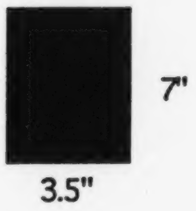
$$a^2 + b^2 = c^2$$

where a and b are the short sides of a right triangle and c is the hypotenuse

AREA WORKSHEET

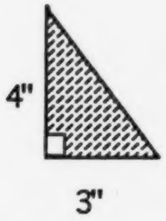
Directions: Find the area of the following geometric figures. Show all answers to three decimal places.

1.



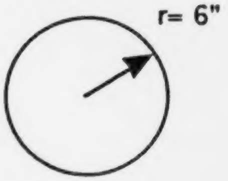
Area = ______

2.



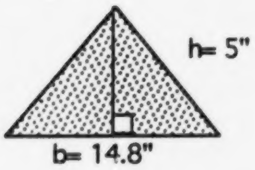
Area = ______

3.



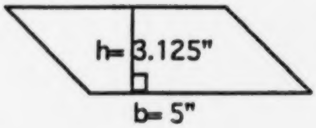
Area = ______

4.



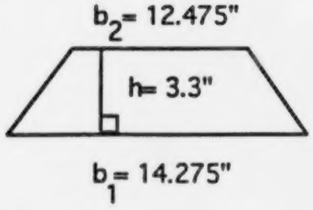
Area = ______

5.



Area = ______

6.



Area = ______

RATIO WORKSHEET

Stress

1. What is the stress on an object if the force is 100 lb and the area is 40 square units?
2. What is the stress on an object if the force is 250 lb and the area is 35 square units?
3. What is the stress on an object if the force is 125 lb and the area is 27 square units?
4. What is the stress on an object if the force is 77 lb and the area is 23 square units?
5. What is the force on an object if the stress is 1.3 lb/square unit and the area is 7 square units?

Strain

1. What is the strain on an object if the original length was 14 units and the new length is 12 units?
2. What is the strain on an object if the original length was 72 units and the new length is 68 units?
3. What is the strain on an object if the original length was 55 units and the new length is 44 units?
4. What is the strain on an object if the original length was 109 units and the new length is 122 units?
5. What is the strain on an object if the strain-is 6% and the new length of the object is 89 units?

Acid Rain

"Pay Now or Pay Later"

A role-playing exercise with in-depth
background information
to be used as a curriculum integration tool

Technology Systems Section

TECHNOLOGY SYSTEMS
INSTRUCTOR'S RESOURCE SHEET 43
(3–4 DAYS)

ACID RAIN: "PAY NOW OR PAY LATER"

Essential Elements: 8, 11
TAAS Objectives: Language Arts: RC 1–6; WC 1–4

Activity Overview

Each class will be considered a "small town" for a role-playing exercise. They will hold a gubernatorial debate in each town about the environmental and economic concerns of legally forcing a local power plant to install expensive "stack scrubbers." Each student will be given a description of the life and concerns of a character they will be asked to play. These characters represent real-life people with real-life concerns about the effects of acid rain on their communities (see descriptions). Each team will be asked at the end of the debate to "elect" a politician who will enforce one side of the technological issue over another.

Challenge Statement

The production of energy by any process has both positive and negative effects on people and their environments. This exercise introduces a process of energy production (coal-burning power plants) and incorporates a real-life "no-win" situation based on a real-life technological problem.

Systems Model

Resources
Students
Character descriptions
Props for debate

Processes
Role-playing
Research
Critical thinking
Debating

Applications
Environmental issues
Critical thinking
Technological problem solving

Impact
Clean air and water
Environment
Social responsibility

Interfacing with Other Disciplines

Language Arts: Students will read character descriptions for role-playing, research acid rain, write a role-playing script, and debate an environmental issue.

Mathematics:	Students will understand environmental issues as they relate to money.
Science:	Students will understand the dynamics of acid rain and environmental cleanup.
Social Studies:	Students will learn about the impact of acid rain and the ripple effects of environmental cleanup. They will witness the role of political debates in social decisions. This activity can be modified to include actual legal issues that would support history and government classes.

Critical Thinking Skills Reinforced

Students will have an opportunity to formulate an opinion about a critical environmental issue. They will research the topic and apply that information to their own concerns and interests to vote for a candidate who will support their choice.

Teaching Tips

1. Introduce the role-playing exercise at least one day before the debate, and assign roles to the students to give them time to consider their characters and research acid rain. The entire class will research the topic and write a short report.
2. The first 15 minutes of debate day—Encourage the students to informally lobby with the other characters, emphasizing personal views about the upcoming town meeting.
3. The first 30 minutes of debate day—Hold a "town" gubernatorial debate with each of the candidates at the front of the room behind a set of podiums. Encourage two students to field questions and concerns from the town members.
4. Hold a secret ballot to elect a governor based on a technological issue.
5. Ask students who are very outspoken or vocal to play the roles to enhance and fuel the debate.
6. After the debate, ask students to share their opinions about the topic.

Instructional Strategy

Your students will form opinions about an environmental issue based on lectures, research, and activities concerning the effects of acid rain. Lead them through a role-playing activity designed to bring out social and environmental concerns. Focus on the right to individual differences and the obligation for social responsibility, realizing that social responsibility is often perceived from different viewpoints.

Equipment/Supplies

1. Copies of Character Descriptions
2. Classroom setup for a formal town meeting (podiums, chairs, etc.)
3. Slide projector, screens, and slides to enhance speeches if available (charts, graphs, actual affected lake areas, etc.)

Evaluation Key

Monitoring by the teacher and participation by each student.
Grading of individual reports if assigned

Support Materials

1. Schwaller, Anthony E. *Transportation, Energy, and Power Technology.* Albany, N.Y.: Delmar, 1989.
2. "Acid Rain" video from Region I Educational Services

Modifications for Handicapped, Disadvantaged, and LEP Students

Actual researched speeches supporting each side of the issue written by the students for the debate would enhance the level of learning.

TECHNOLOGY SYSTEMS
STUDENT ACTIVITY 43

ACID RAIN: "PAY NOW OR PAY LATER"

Activity Overview

In this exercise you will learn about acid rain, how it is produced, and what real effects it has on us and our environment. Your task will be to make a real-life judgment about what should be done. This judgment will both help and hurt people and the environment on each side of the issue. You will be asked to choose the best of two "no-win" courses of action. Good Luck!

Challenge Statement

The advancement of technology always results in a compromise between the needs of people and their environment. Tough political decisions adversely affect both people and the environment almost every day. It is important to make the study of such decisions part of general education in order to make you and your future generations more "informed" voters.

Objectives

- To use the knowledge and concepts introduced in the classroom
- To evaluate a real-life technological issue

Vocabulary/Concepts Reinforced

- Scrubbers
- Lignite
- Anthracite
- Bituminous
- Peat
- Turbine
- Entropy
- "Liming a lake"

Equipment/Supplies

- Ask your teacher to provide a slide projector or overhead projector, if you wish to use visuals to enhance your points during the debate.
- You will need the description of the character you will be playing.
- Your class may want to "dress the part" on the day of the debate.

Introduction

The character descriptions on the following pages provide an introduction to this topic.

Procedure

1. Read all of the character descriptions so that you know your own situation as well as others' going into the debate.
2. Research further the subject of acid rain to enhance your speeches during the debate.

3. Write your speech or report and make any visuals needed to help you make your point, if they are assigned.
4. Come to the class debate prepared. Listen carefully to both sides.
5. Vote on the candidate who most accurately represents your opinion.
6. Discuss the right to individual differences and the obligation for social responsibility, realizing that social responsibility is often perceived from different viewpoints.

Evaluation
On this portion of the Acid Rain unit, you will be evaluated on your level of participation and your written speech or report.

CHARACTER DESCRIPTIONS

Governor FOR Scrubbers
You have a very good chance of being elected governor because of your campaign to create a law requiring the local coal power plant to install scrubbers. Strong points to use to persuade people to vote for you are that scrubbers will greatly reduce pollution in the air and keep the surrounding environment healthier. This will keep the tourism industry in your area up—which means more money and jobs in that area for your state. A bad point is that it will drive away industry that uses electrical power (loss of money and jobs), because the rates will go up for everybody (including you). How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Governor AGAINST Scrubbers
You have a very good chance of being elected governor because of your campaign to not raise taxes and to create jobs by assuring large companies potentially moving to your state that power rates will be the lowest around. This means that you will fight a bill designed to force the coal-burning power plants to install scrubbers. Some good points you could use to persuade others are that your efforts will attract businesses that use great amounts of electric energy, in turn creating more jobs for your state, and that electric rates will be the lowest around for everyone (including you). You will have to face several difficult issues. One is the pollution that would hurt farmers and their crops and force them to raise their prices. Another is that the tourism industry will decline because of the slow deterioration of the local environment. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Successful Farmer
Your farm is a very large and modern one. You raise a variety of food and grain crops as well as dairy and beef cattle. Most of your machinery runs on electricity (the automatic milkers, computer-assisted irrigation system, etc.). The pollution and acid rain have begun to affect both your crops (lower yields) and your cows (higher incidence of sickness and lower birth rate), but nothing serious yet. All you need to do to go on being successful is to raise your selling prices slightly. Here's the kicker: if scrubbers are put in the power plants, it will raise your electric bill, which is large to start with. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Large Lake Resort Owner
You own and manage a large, successful lake resort that serves thousands of people a year. The main attractions of your resort are the beautiful trees and wildlife area where the resort is located, the great lake fishing, and the wonderful food served in your restaurant. You notice a slight decline in the fish population, and some of the flowers usually in bloom this time of year are not. If scrubbers are put in the power plants, they will keep the environment clean. However, your electric bills will rise, so you will have to charge your customers more money. If they are not put in, crops will have smaller yields, food prices will go up slightly, and you again will have to charge your customers more for their meals. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Owner of a Large Company That Makes Electric Appliances
Guess what? You're rich! (You like this exercise already, don't you?) Your company is looking for a new place to build a huge plant. It will mean many jobs for that community and great

community growth. Your company is looking for cheap electric rates, because your plants run mainly on electricity. If you can convince the people of the community not to vote for a bill that will force power plants to install scrubbers, you will have the cheapest electric bills around—which means faster growth for your company. If scrubbers are put in, your sales of electric appliances in this part of the country will decline, whether or not you build here, because the cost of running them will increase. Here is the last concern: you and your family love to go camping and fishing at the local resort. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Owner of an Electric Appliance Store
You and your business are doing very well! You have just made a down payment on a new house for you and your family and are looking at buying a new car. If a bill is passed forcing power plants to install scrubbers, your sales of appliances will decline (goodbye new car!). Your business will also decline, because you know that the power company will raise the cost of electricity, and the stereos and big-screen TVs will become luxury items too expensive to run. Start by asking people if they like their electric appliances and like paying low electric bills. Here's the kicker—you and your family like to camp and fish at the local resort, which can be hurt by acid rain. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Environmentalist
You have a tough job! You believe (as most people do) that the environment should be taken care of. However, if scrubbers are put in the power plants, jobs in this community will be lost, electric rates will increase (for you also), and sales of electronic products in the area will go down. However, tourist rates will remain the same, and the crops, animals, lakes, forests, and people will have a lower risk factor of getting sick from either the pollution or the acid rain. Here's the kicker: you work at the electric appliance store and you have been doing very well. (Find the electric appliance store owner and ask his or her concerns.) How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

College Student
It's your last year in college; you have your own apartment and work at the local lake resort to pay for college, rent, and bills. If the power plants are forced to install scrubbers, it will mean more money paying off the electric bill and less money to go on dates, pay for college, or buy a car. (Bummer, huh?) If scrubbers are not put in, this could jeopardize your job at the resort, since tourists are already commenting to the owner that the fishing isn't as good as the year before, and they are looking for other places to vacation. If the resort goes out of business, so does your only means of paying for college. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Owner of a Plant That Makes Scrubbers
You are the owner of a large, successful company that makes scrubbers. If a bill is passed that forces power plants to install scrubbers, you have a chance to make a big sale. However, all of your machinery runs on electricity and if the scrubbers are installed, your large electric bills will become huge. You will either have to pass this expense on to consumers, or your business costs will cause the "boom" to be more of a "trickle." Here's the kicker: if you pass the costs on to the consumer, you will probably lose the sale, and future sales, because of another plant making cheaper scrubbers by using cheaper electricity. How will you vote, and how will you convince others to vote the same way? GOOD LUCK!

Physical Science Section

PHYSICAL SCIENCE
INSTRUCTOR'S RESOURCE SHEET 43
(2 DAYS)

ACID RAIN: "PAY NOW OR PAY LATER"

Activity Overview

The instructor will demonstrate chemical processes involved in acid precipitation through combustion of coal and water gas filtration. The demonstration will measure (1) pH of filter water before and after combustion and (2) the effect of using scrubbers. Optional measurements can include (1) chemical and physical change in the coal before and after combustion, (2) volume of gas filtered, (3) effects of quantity and quality of filters in scrubber, and (4) effects in the amount of coal used during combustion relative to the change in pH.

Challenge Statement

The demonstration will enhance the technology role-playing exercise in terms of supporting the economic and environmental debate dealing with the acid precipitation issue. The demonstration can be integrated into other disciplines such as chemistry (chemical and physical changes involved), environmental science (environmental effects of acid precipitation), mathematics (measurement analysis) and social studies (social and political impacts of acid precipitation).

Interfacing with Other Disciplines

Environmental Science:	Demonstrate the chemical processes involved in the production of acid precipitation through the combustion of coal and water filtration of gases.
Physical Science/ Chemistry:	Investigate the chemical reactions involved in acid precipitation and the effects on the pH of water.
Mathematics:	Measure the products and by-products from the demonstration. Analyze the data from the demonstration. (Refer to Mathematics Module.)
Social Studies:	Research the social and political impacts of acid precipitation.

Critical Thinking Skills Reinforced

Students will use the results of the acid precipitation demonstration to support the technology role-playing exercise. They will design modifications for the demonstration. Throughout the demonstration, they will make observations, record data, and determine results. Evaluating the long-term effects of acid precipitation and possible solutions will give them an understanding of environmental problems and solutions.

Teaching Tips

1. Before classroom demonstration, assign instructor-selected background readings.
2. Set up demonstration apparatus in advance, preferably under a laboratory vented hood or in a well-ventilated room.
3. Standard laboratory safety precautions should be taken (goggles, lab aprons, etc.).
4. Perform the demonstration before classtime to become familiar with the procedure.
5. A relatively sensitive pH meter (accurate to at least 0.1 pH) is needed for more accurate readings. Use known pH buffer solutions to standardize pH meter.
6. Show students the overhead projection of the demonstration setup. Explain the procedure and the chemical reactions that are to occur before the actual demonstration.
7. Refer to the attached Instructor's Demonstration Procedure supplemental handout.

8. The complexity of this activity can be increased in terms of quantifying the amounts of coal combusted, the differences in pH change, the volume of gas filtered, and size of "scrubber." Rain samples from various sources throughout the United States can be obtained, via correspondence, to be tested.

Instructional Strategy

Introduce background information on the chemistry involved in acid precipitation through lecture and demonstration. Demonstrate the operation of the pH meter with and without in-line filter. Use the data to support the technology class role-playing debate.

Equipment/Supplies

1. pH meter (accurate to at least 0.1 pH)
2. Pyrex test tube (approx. 25 ml, size may vary)
3. Test tubes (approx. 75 ml) and stopper (2-hole)
4. Vacuum pump (60-ml syringe and 2-way valve)
5. In-line filter (moist cigarette filters or cotton inside larger bore aquarium tubing)
6. Tubing (standard aquarium tubing, small and large bore)
7. Air diffuser (high-volume, small-pore aquarium aerator)
8. Bunsen burner
9. Igniter (matches)
10. Buffer solutions (pH 7) (to standardize meter)
11. Standard laboratory safety equipment (goggles, aprons, vented hood)

Evaluation Key

Students will be evaluated by their oral responses to questions.

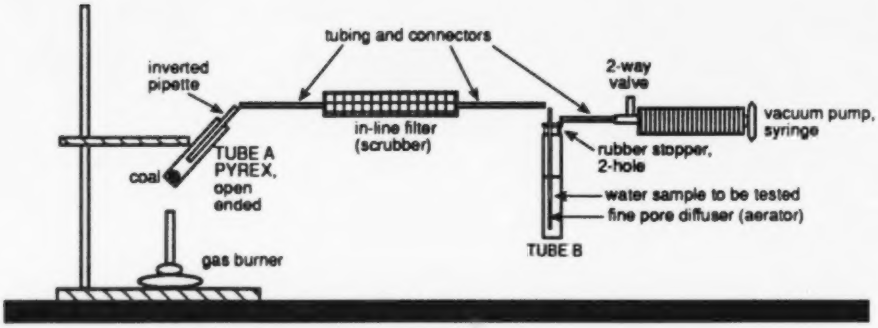
Support Materials

1. Resource books (refer to attached supplemental reading list)
2. Information gained from local learning resource centers and corresponding curricula
3. Transparency 43-1

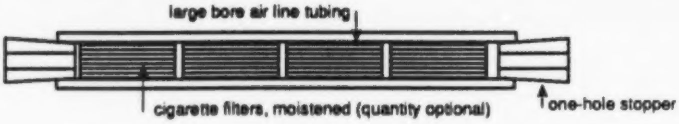
Modifications for Handicapped, Disadvantaged, and LEP Students

Students should be closely monitored, and safety must be emphasized.

INSTRUCTOR'S DEMONSTRATION PROCEDURE



IN-LINE "SCRUBBER" FILTER


large bore air line tubing
cigarette filters, moistened (quantity optional)
one-hole stopper

SAFETY PRECAUTIONS: Goggles and aprons should be worn at all times. Demonstrations should be performed in a laboratory hood or, at the very least, a well-ventilated room. Standard safety guidelines should be followed regarding the use of the gas burner.

GENERAL DEMONSTRATION SETUP PROCEDURES

APPARATUS SETUP: Use ring stands and clamps to support Tube A and Tube B. Allow for enough tubing to position Tube B and the vacuum pump away from Tube A and the burner. Set up "scrubber" assembly, and install if performing the "with scrubber" demonstration. The amount of cotton or clean cigarette filters may vary depending on the amount of coal used. It is important that the cotton filters form a tight fit inside the tubing section. Place small sample (volume depends on size of test tube; between 0.5 and 1.0 gram is recommended) of coal inside Tube A and insert inverted pipette and connecting tube (weight can be determined if quantification is desired).

Measure the initial pH for a 50-ml sample of distilled water and record. (Volume of sample may vary depending on the size of the test tube. The volume of the sample should submerge the air diffuser). After measuring pH of sample, pour into a clean Tube B. Attach a new air diffuser to the air-line tube, and fit stopper into Tube B (the diffuser needs to be completely submerged). Attach vacuum pump, and test to see if air can be drawn through the system. Bubbles should appear from the diffuser. Demonstration is ready to begin. (It is recommended that the setup procedure described above be carried out prior to class time).

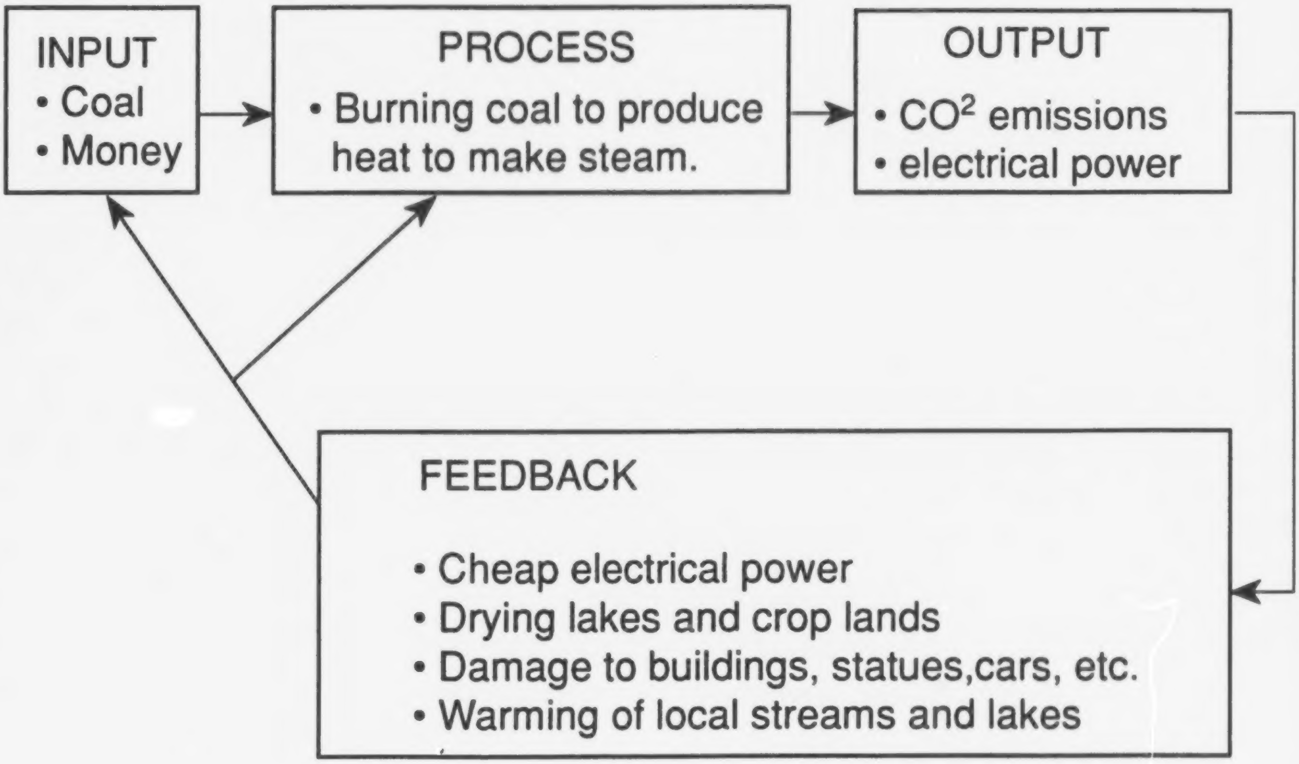
COMBUSTION PROCEDURE: Be careful not to cap or seal Tube A during combustion. Use an inverted large-bore pipette or glass tube as a siphon inside Tube A (refer to diagram). (Tube A needs to be open to allow for gas expansion and ventilation by the vacuum pump.) Position gas burner below Tube A. Light gas burner using standard safety procedures. After approximately one minute, smoke should begin to fill Tube A. As Tube A begins to fill with smoke, slowly pump the smoke through the assembly using the vacuum pump. If quantifying the air volume, count the number of "pumps" (ml). Depending on the volume of coal (between 0.5 and 1.0 gram is recommended), the amount of time to complete the vacuuming procedure will take approximately 5 to 10 minutes. The heated coal will be "snapping" and "popping" in addition to smoking during the procedure. When finished, turn the gas off and carefully remove the stopper from Tube B. Measure and record the final pH readings from the water sample. Be sure to rinse Tube B before introducing the second fresh sample of distilled water.

Repeat procedure with the scrubber assembly. Use another clean Tube A and a fresh sample of distilled water. CAUTION: Tube A from the first demonstration will be very hot. (Optional measurement: The cinder residue can be weighed and compared to the initial weight of coal.)

EXPECTATIONS: Depending on the accuracy of the pH meter and the other variables (amount of coal, volume of air passing through the system, number of filters used, etc.), there should be an obvious decrease in the pH reading between the initial distilled water and the same sample after the combustion procedure. Using the scrubber apparatus in the system should result in a decrease in the pH reading, but not as much as without the scrubber.

Systems Model:

Acid Rain



INPUT
- Coal
- Money

PROCESS
- Burning coal to produce heat to make steam.

OUTPUT
- CO^2 emissions
- electrical power

FEEDBACK
- Cheap electrical power
- Drying lakes and crop lands
- Damage to buildings, statues,cars, etc.
- Warming of local streams and lakes

TRANSPARENCY 43-1

ACID RAIN: "PAY NOW OR PAY LATER"

Activity Overview

You will observe a demonstration of the chemical processes involved in the production of acid precipitation through the combustion of coal and water filtration of gases. You will analyze data including (1) the quantity of coal before and after combustion, (2) the volume of gas filtered, (3) the pH of filter water before and after combustion, and (4) the effect of using scrubbers. You will give this information to the technology classes to use in their role-playing exercise.

Challenge Statement

You will provide physical evidence to make a judgment regarding the economic and environmental debate over the acid precipitation issue.

Objectives

- To observe the demonstration with and without the use of the scrubber (filter attachment), and use the results to support the role-playing exercise
- To record the following data obtained from the demonstrations: pH readings of water samples before and after combustion and pH readings with and without scrubber; optional readings for comparative analyses: volume of coal before and after combustion, volume of air filtered, and size of scrubber

Vocabulary/Concepts Reinforced

- Acid precipitation
- Acid precursors
- Lake acidification
- pH (acids, bases)
- Acid Precipitation Act
- Dry deposition
- Oxides
- Wet deposition

Equipment/Supplies

- Notebook
- Supplemental reading list

Procedure

1. As the demonstration is performed by your instructor, you are to record the pH readings before and after each run, including with and without the scrubber (in-line filter). You are to use the results to defend your stand in the technology class debate.
2. Your instructor will pass on your findings to the technology class to prepare the debate.
3. Observe the debate and vote for the candidate of your choice.

Evaluation

You will be graded on the accuracy of your recorded data.

ACID RAIN: SUPPLEMENTAL READING

Beamish. R.J. "Acidification of Lakes in Canada from Acid Precipitation and the Resulting Effects on Fishes." *Water, Air, and Soil Pollution.* 6 (1976): 501–514.

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Mathematics Section

ACID RAIN: "PAY NOW OR PAY LATER"

Activity Overview

Teams of two or three students will plot data collected from the science classes on a scanner plot and make predictions from their scanner plot that fit a linear model. In addition, they will make a convincing informal argument to justify their prediction about the election, using the available data.

Challenge Statement

Mathematical models of real-life problems help scientists and technologists design realistic solutions to problems like acid rain. With this type of information, the role-playing activity will take on an added dimension for the students.

Critical Skills Reinforced

Students will apply mathematics skills to a real-world problem. They will transfer plotted information to a prediction about a political election and write their ideas in an opinion statement.

Teaching Tips

1. Acquire the recorded results of the pH readings of water samples before and after combustion and pH readings with and without scrubber from the science teacher.
2. Present the topic of acid rain and the issues of the election to your students.
3. Review constants, variables, and graphing techniques, if this is not incorporated into the current unit.
4. Assist the students in plotting the data.
5. Discuss the implications of the data as it applies to the environment.
6. Give students adequate time to form an opinion and make a prediction.

Instructional Strategy

Introduce the topic of acid rain and the election through lecture and discussion. Assign cooperative groups of students to plot and analyze data. Monitor students as they form opinions and make election predictions. Encourage a free flow of ideas, and emphasize freedom of choice in politics. Lead students to the conclusion that math can be used in organizing information and ideas into a visible, presentation-ready form.

Equipment/Supplies

1. Overhead projector
2. Pencil and paper

Evaluation Key

Students will be graded on the completion of the work in line with the standards you set for your class.

Modifications for Handicapped, Disadvantaged, and LEP Students

As students will be working in teams, all students should be able to participate in this activity.

MATHEMATICS
STUDENT ACTIVITY 43

ACID RAIN: "PAY NOW OR PAY LATER"

Activity Overview

Teams of two or three students will plot data collected from the science classes on a scanner plot and make predictions from their scanner plot that fit a linear model. In addition, you will make a convincing informal argument to justify your predictions about the election, using the available data.

Challenge Statement

Mathematical models of real-life problems help scientists and technologists design realistic solutions to problems like acid rain. With this type of information, the role-playing activity will take on an added dimension for you.

Objectives

- To plot and analyze data as a basis for prediction
- To realize a real-world use for mathematics

Vocabulary

- Constants
- Mathematical model
- Variables
- Linear
- Scatterplot
- Linear and nonlinear

Equipment/Supplies

- Overhead projector
- Pencil and graph paper
- Rulers
- Notebooks

Procedure

1. Listen to and discuss the information about acid rain and the part it plays in a small-town election.
2. Define *constant* and *variable*. Review plotting x, y coordinates. Define and practice a scatterplot. Define *linear* and *nonlinear* models.
3. Plot the data from the science department to organize the information.
4. Study the information.
5. Discuss the results in your group, and write down your individual prediction about the election.
6. If possible, go to the debate and see who wins.

Evaluation

You will be graded on your class participation and the neatness and accuracy of your graph.

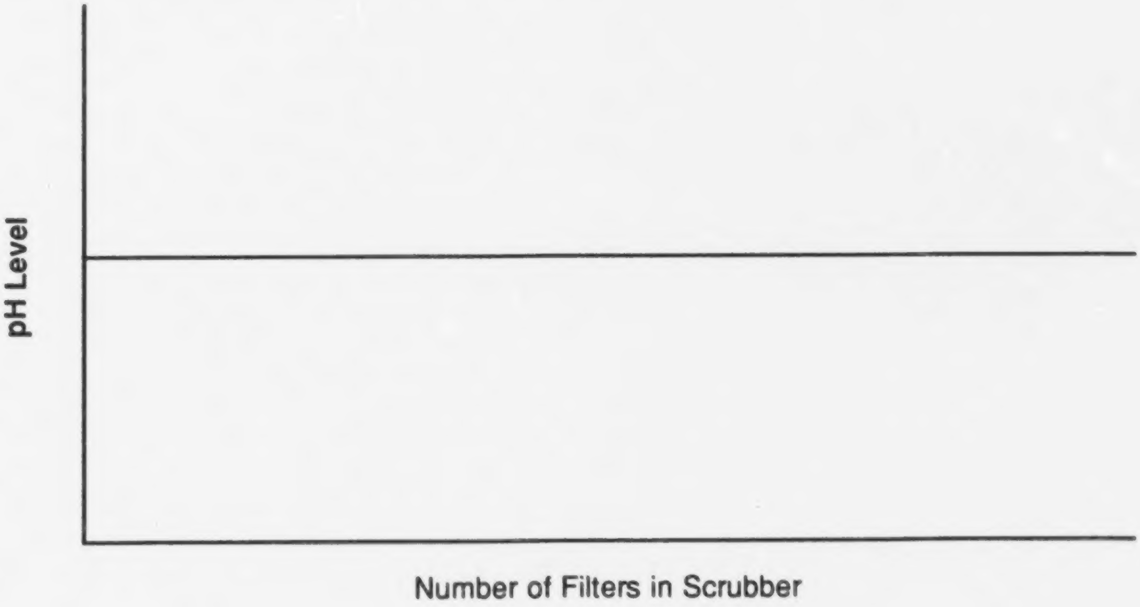
COOPERATIVE GROUP ACTIVITY

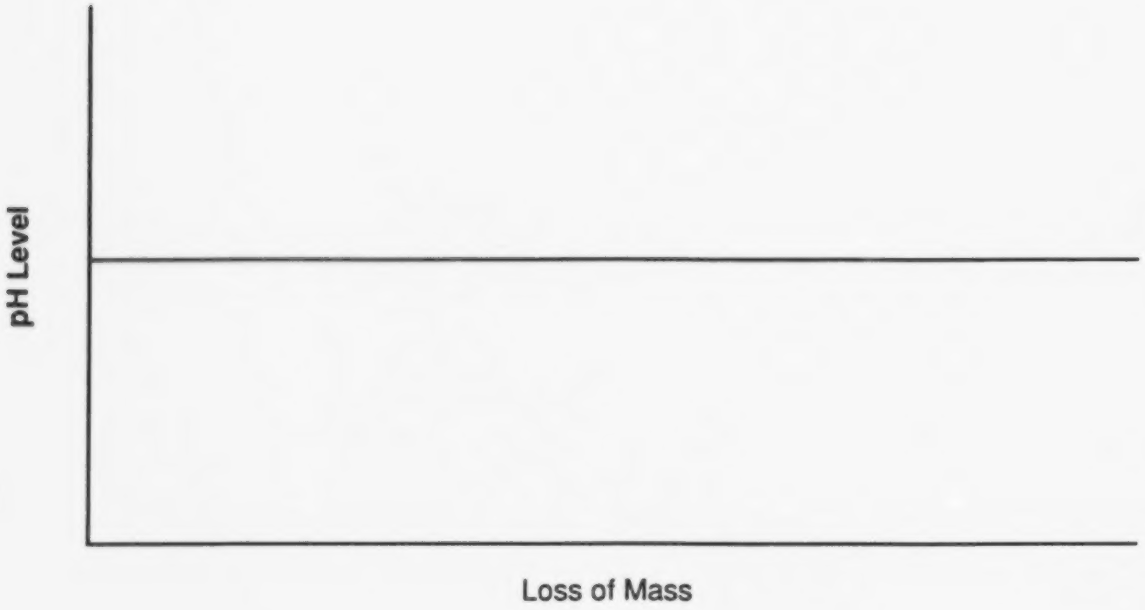
GROUP MEMBERS:

1. Enter the data from your science experiment in the following table.

# of filters	pH level	Original mass	Final mass	Change in mass

2. Plot the data from the above table on the following scatterplots.





3. Describe the changes that occur in pH level as the number of filters in the scrubber is increased. Draw a straight line that seems to fit the data the best. Use this line to predict the effect on the pH level of increasing the number of filters by 2, 5, and 10.

4. Describe the changes in pH level that occur as the loss of mass increases. Draw a straight line that seems to fit the data best. Use this line to predict the effect on the pH level when the loss in mass increases by 5 grams, 10 kg, and 1 kg.